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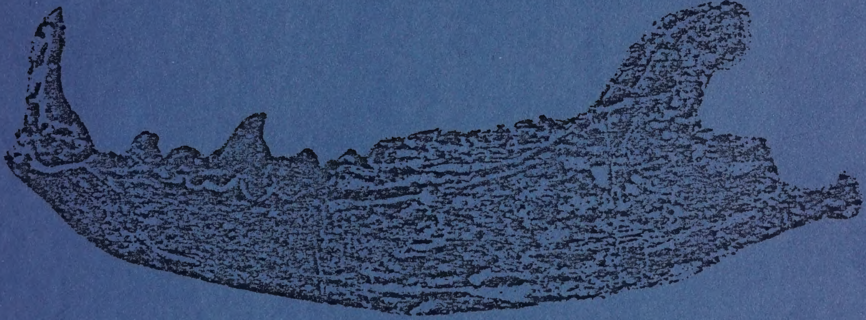
FOSSIL VERTEBRATES
OF THE GRAND JUNCTION AREA

Harley J. Armstrong and Allen J. Kihm



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Cover illustration of new species of Genus Priacodon found at Fruita Paleontological Area by Rasmussen and Callison (1981).

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An Evaluation of the Fossil Vertebrate Resources of the Glade Park and Mount Garfield Planning Areas, Grand Junction District of the Bureau of Land Management, Western Colorado

BLM Contract No. CO-070-CT0-02

GRI/PAL Report No. 8150
December 1990

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Prepared by

Grand River Institute
1020 Colorado Avenue
Grand Junction, Colorado 81501

Project Paleontologist: Harley J. Armstrong
Principal Investigator: Allen J. Kihm

Submitted to

The Bureau of Land Management
Grand Junction District Office
764 Horizon Drive
Grand Junction, Colorado 81506

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An Evaluation of the Fossil Vertebrate Resources of the Glade Park and Mount Garfield Planning Areas, Grand Junction District of the Bureau of Land Management, Western Colorado

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Grand River Institute
1030 Colorado Avenue
Grand Junction, Colorado 81501

Project Paleontologist: Harley J. Armstrong
Principal Investigator: Allen J. Kihm

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Abstract

This study identifies and evaluates the fossil vertebrate resources of the Glade Park and Mount Garfield Bureau of Land Management Planning Units. It is based on a literature and collections search and the results of a field survey. For each formation, a description is given of the sediments, environment of deposition, outcrop nature, area of exposure, history of field work in the area, and occurrence of fossil vertebrates. Each of the thirteen formations in the study area is assigned to one of four groups based on its overall fossil-producing potential. Recommendations for management and mitigation are given for each of the four groups. Locations and descriptions of the twenty-four areas surveyed and the twenty-three known fossil localities within the study area are provided.

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Preface

On 25 April 1980 Grand River Institute was awarded Contract No. CO-070-CTO-02 by the Bureau of Land Management, Grand Junction District Office, to conduct a literature search and a paleontological sampling survey of geologic formations present in the Mount Garfield and Glade Park Planning Units. Principal Investigator for the project was Allen J. Kihm. Project Paleontologist was Harley J. Armstrong. Field work was conducted by Armstrong and Kihm, who were assisted at various times by Carl E. Conner and Diana L. Langdon.

The project was administered by Grand River Institute, 1030 Colorado Avenue, Grand Junction, Colorado 81501, under the direction of Carl E. Conner. The report was written by Harley J. Armstrong and Allen J. Kihm. Diana L. Langdon edited the manuscript.

Acknowledgments

Many people have helped with the preparation of this report and are to be commended for their enthusiastic assistance and support. We would like to thank the following people from whom we received responses to our letters: J. Clay Bruner, Collection Manager, Vertebrate Paleontology Section of the Field Museum of Natural History, Chicago; George C. Callison, Assistant Professor of Biology at California State University at Long Beach; William A. Clemens, Department of Paleontology at the University of California, Berkeley; E. H. Colbert and Timothy Rowe of the Museum of Northern Arizona; Farish A. Jenkins, Jr., Professor of Biology and Curator of Vertebrate Paleontology at the Agassiz Museum of Comparative Zoology at Harvard University, Cambridge, Massachusetts; James A. Jensen of the Earth Sciences Museum at Brigham Young University, Provo, Utah; Jason A. Lillegraven, Department of Geology, University of Wyoming at Laramie; James H. Madsen, Jr., Utah State Paleontologist; and George Gaylord Simpson, President, The Simroe Foundation, Tucson, Arizona. Interviews were conducted with George Callison; Lance Eriksen, Paleontologist at the Museum of Western Colorado, Grand Junction; Jim Johnson, Geologist at Mesa College, Grand Junction; Don Lindsey, Curator of Paleontology, Denver Museum of Natural History; Al Look, well-known local amateur paleontologist; and Robert G. Young, Geologist with Hunt Oil.

John Crouch and Beverly Duellman of the Grand Junction District Office of the Bureau of Land Management provided paleontological manuscripts written for the BLM. George L. Callison and Thomas E. Rasmussen generously supplied a faunal list for their work at the Fruita Paleontological Area and a photo of their new species (Genus Priacodon) for inclusion in the report. Don Lindsey hosted a visit to view the Mancos Shale fossils from near the area. The Denver Museum of Natural History granted permission for inclusion of the Xiphactinus fish and hadrosaur footbone prints in this report. Additional information on the area was provided by Peter Robinson, Director, University of Colorado Museum, Boulder; and several employees of the Colorado National Monument. Resources in the form of office space, use of collections, maps, and publications, were made available to us by the University of Colorado Museum.

Most important we would like to thank Diana L. Langdon who helped arrange and edit the report; Carl E. Conner who designed the cover and helped with various aspects of the manuscript; Lester A. Wheeler who drafted Figures 1, 2, and 3; Sally M. Crum who helped with the figures and photographs; and Amy L. Reeder and Joan M. Kubick who typed the report. Without their help, completion of this report would have been considerably more difficult.

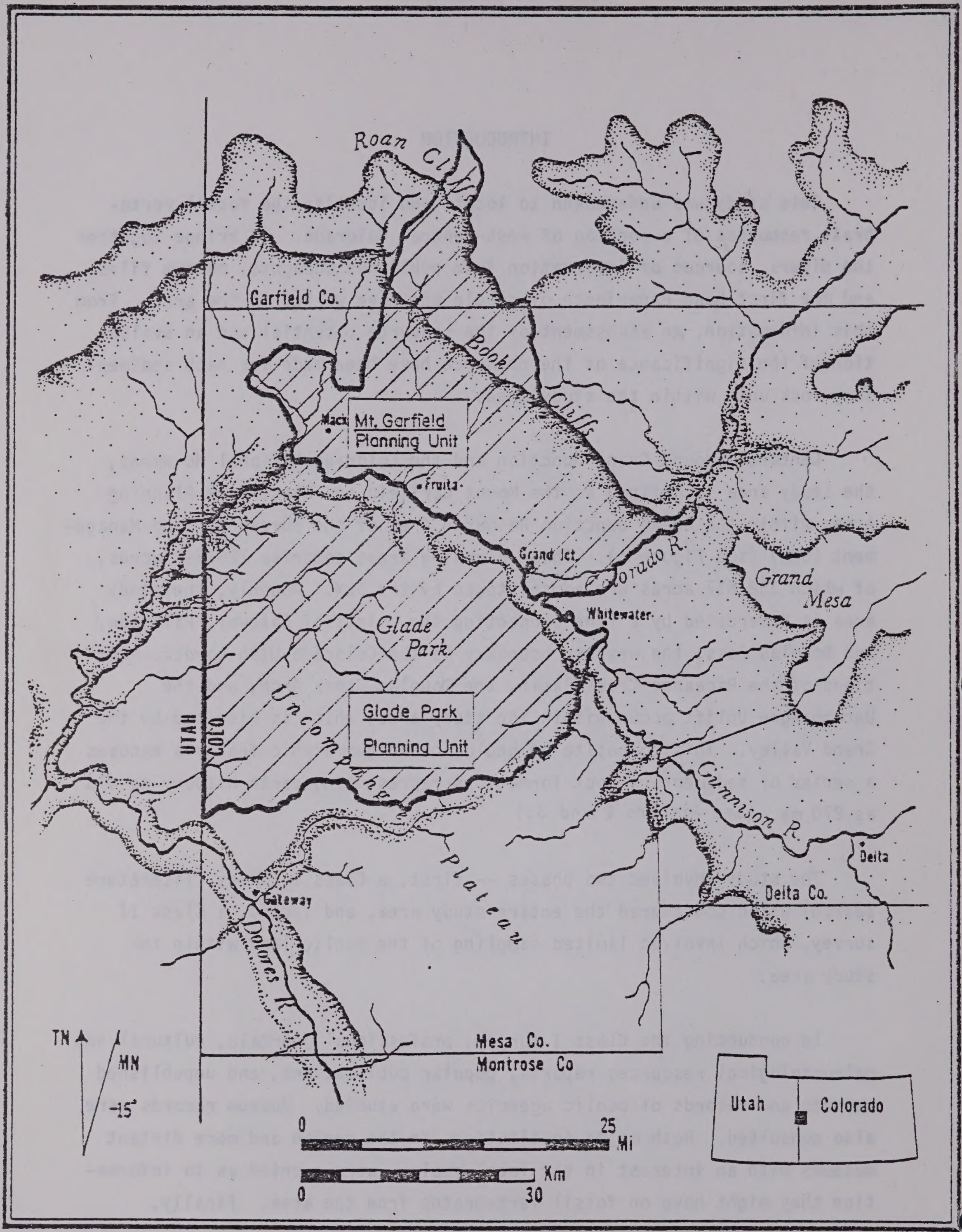
INTRODUCTION

This study was undertaken to locate and identify the fossil vertebrate resources of a portion of west-central Colorado. It brings together the divers sources of information from published accounts, museum files, and the first-hand experience of people who have worked in the area. From this information, an assessment of the resource potential and an evaluation of the significance of the resource have been made for each sedimentary rock unit within the study area.

Centered around Grand Junction and the Colorado National Monument, the study area is defined as the Mount Garfield and Glade Park Planning Areas within the Grand Junction Resource Area of the Bureau of Land Management (BLM) (see Figure 1). These planning areas comprise 723,692 acres, of which 358,617 acres are administered by the BLM. Roughly, the study area is demarcated by a line connecting the points of Gateway, Palisade, and Douglas Pass; the western boundary is the Colorado-Utah border. Portions of the Piceance Creek Basin, the Douglas Creek Arch, and the Uncompahgre Uplift occur within the study area, which is bisected by the Grand Valley. This composite of geologic and geomorphic features exposes a series of sedimentary rock formations representing earth history as old as 270 ma. (See Figures 2 and 3.)

The study involved two phases -- first, a Class I survey (literature search) which considered the entire study area, and second, a Class II survey, which involved limited sampling of the public land within the study area.

In conducting the Class I survey, professional journals, cultural and paleontological resources reports, popular publications, and unpublished reports and records of public agencies were studied. Museum records were also consulted. Both major institutions in the region and more distant museums with an interest in the local geology were queried as to information they might have on fossil vertebrates from the area. Finally,


Roan Cliffs
Garfield Co.
Book Cliffs
Mack
Mt. Garfield Planning Unit
Fruita
Grand Jct.
Colorado R.
Grand Mesa
Whitewater
Glade Park
Uncompahgre Plateau
Glade Park Planning Unit
UTAH
COLO
Gunnison R.
Delta
Delta Co.
Gateway
Dolores R.
TN
MN
-15°
Mesa Co.
Montrose Co
Utah
Colorado
0
25
Mi
Km
0
30

Map of west-central Colorado showing location of project area (hachured).

Figure 1.

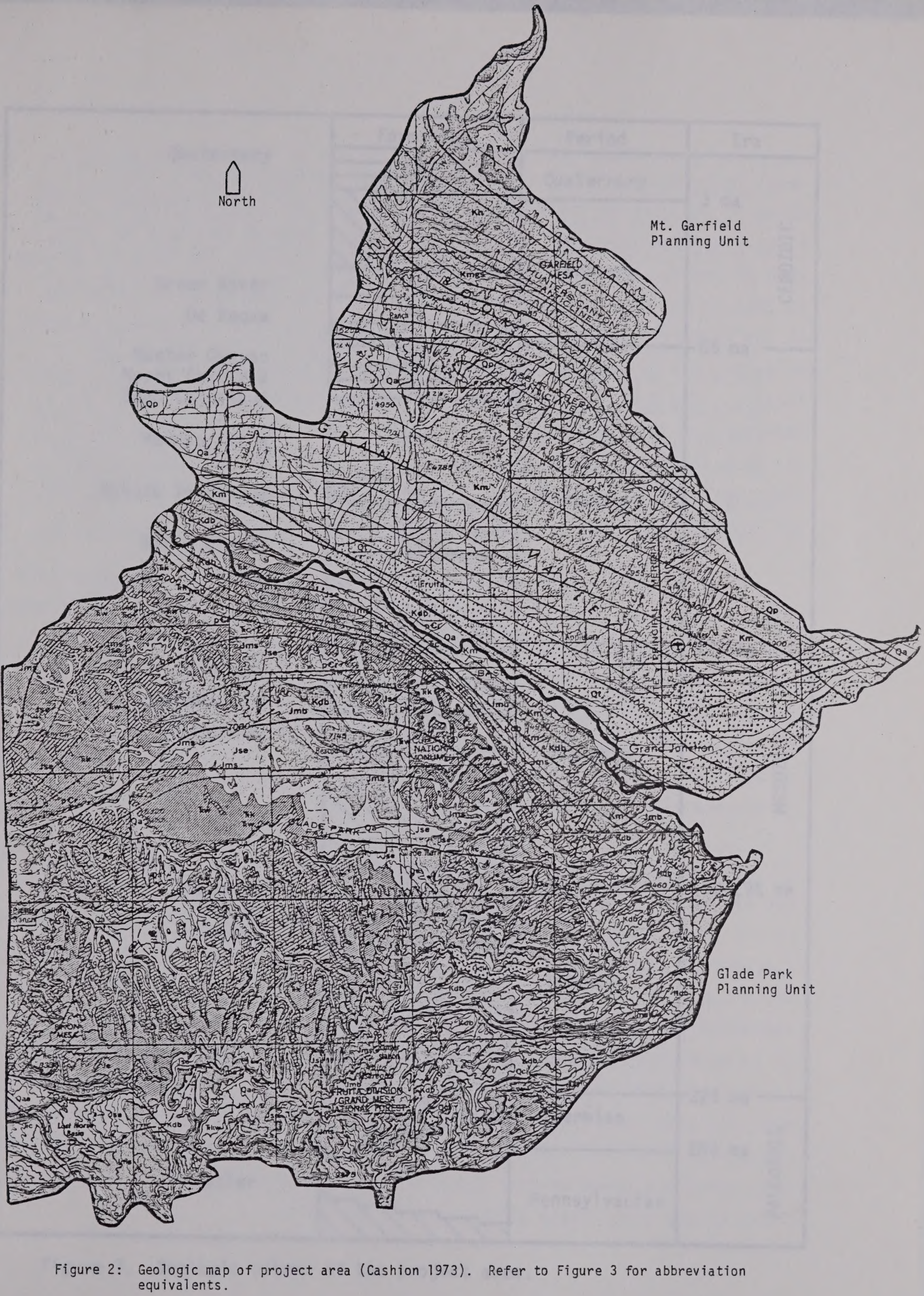

North
Mt. Garfield
Planning Unit
Glade Park
Planning Unit
GARFIELD MESA
HUNTER CANYON ANTICLINE
GRAND VALLEY
Fruita
Grand Junction
Appleton
LINE
NATIONAL MONUMENT
GLADE PARK
FRUITA DIVISION GRAND MESA NATIONAL FOREST
Lost Horse Basin
PINON MESA
MESA CO.
Two
Km
Kmgs
Kdb
Qa
Qp
Qt
Jms
Jse
Jmb
Tkw
Tk
Tc
pCr
Qae

Figure 2: Geologic map of project area (Cashion 1973). Refer to Figure 3 for abbreviation equivalents.

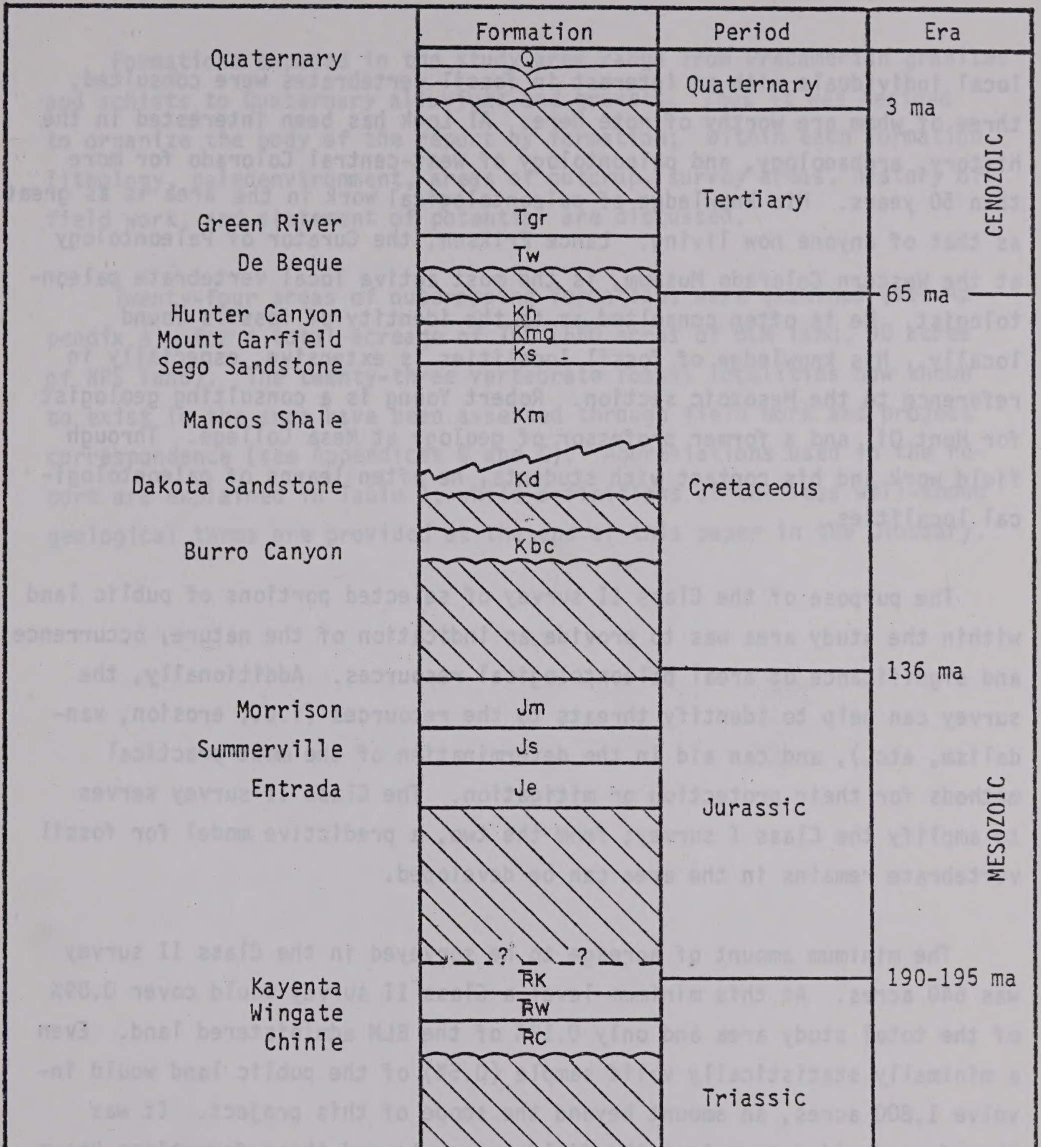

Formation
Period
Era
Quaternary
Q
Quaternary
3 ma
Green River
Tgr
Tertiary
De Beque
Tw
CENOZOIC
65 ma
Hunter Canyon
Kh
Mount Garfield
Kmg
Sego Sandstone
Ks
Mancos Shale
Km
Dakota Sandstone
Kd
Cretaceous
Burro Canyon
Kbc
136 ma
Morrison
Jm
Summerville
Js
Entrada
Je
Jurassic
MESOZOIC
? ?
190-195 ma
Kayenta
ŦRk
Wingate
ŦRw
Chinle
ŦRc
Triassic
225 ma
Permian
280 ma
Cutler
Pc
Pennsylvanian
PALEOZOIC

Figure 3. Geologic column of the project area.

local individuals with an interest in fossil vertebrates were consulted, three of whom are worthy of note here. Al Look has been interested in the history, archaeology, and paleontology of west-central Colorado for more than 50 years. His knowledge of paleontological work in the area is as great as that of anyone now living. Lance Eriksen, the Curator of Paleontology at the Western Colorado Museum, is the most active local vertebrate paleontologist. He is often consulted as to the identity of fossils found locally. His knowledge of fossil localities is extensive, especially in reference to the Mesozoic section. Robert Young is a consulting geologist for Hunt Oil and a former professor of geology at Mesa College. Through field work and his contact with students, he often learns of paleontological localities.

The purpose of the Class II survey of selected portions of public land within the study area was to provide an indication of the nature, occurrence, and significance of areal paleontological resources. Additionally, the survey can help to identify threats to the resources (i.e., erosion, vandalism, etc.), and can aid in the determination of the most practical methods for their protection or mitigation. The Class II survey serves to amplify the Class I survey; from the two, a predictive model for fossil vertebrate remains in the area can be developed.

The minimum amount of acreage to be surveyed in the Class II survey was 640 acres. At this minimum level a Class II survey would cover 0.09% of the total study area and only 0.18% of the BLM administered land. Even a minimally statistically valid sample (0.5%) of the public land would involve 1,800 acres, an amount beyond the scope of this project. It was therefore decided to orient the field survey toward those formations known to be more fossiliferous and extensive, although all sedimentary formations occurring within the study area were visited. It was hoped that, in this way, the most information possible would be generated about those rock units with which the resource manager will most often have to deal. These rock units are shown on four U.S.G.S. geologic maps of the area (Cashion 1973; Lohman 1963; Tweto 1979; and Williams 1964).

Formations exposed in the study area range from Precambrian granites and schists to Quaternary alluviums and gravels. Thus it was decided to organize the body of the report by formation; within each formation, lithology, paleoenvironment, areas of outcrop, survey areas, history of field work, and statement of potential are discussed.

Twenty-four areas of outcropping formations were examined (see Appendix A), for a total acreage of 750 (660 acres of BLM land, 90 acres of NPS land). The twenty-three vertebrate fossil localities now known to exist in the area have been assessed through field work and project correspondence (see Appendices B and C). Abbreviations used in the report are explained in Table 1, while definitions of the less well-known geological terms are provided at the end of this paper in the Glossary.

Table 1

Abbreviations

BLM	Bureau of Land Management
CNM	Colorado National Monument
DMNH	Denver Museum of Natural History
Fm	Formation
FMNH	Field Museum of Natural History, Chicago
GPPA	Glade Park Planning Area
ma	megaannum, 1,000,000 years before present
MGPA	Mount Garfield Planning Area
UCLB	California State University, Long Beach
UCM	University of Colorado Museum, Boulder

PALEOZOIC ERA

Pennsylvanian - Permian Periods

Cutler Formation

The Cutler Formation is a burgundy red to purple, coarse arkosic sandstone to arkosic conglomerate. It rests unconformably on Precambrian basement rocks. The sediments are non-marine, deposited by rivers and streams flowing away from the Uncompahgre Uplift. The sediments began to accumulate in the late Paleozoic when the Ancestral Rockies developed. Sedimentation began as early as the middle Pennsylvanian (300 ma) and continued to as late as the middle Permian (250 ma) (DeVoto 1980). A fossil fauna from Utah indicates an early Permian age (275 ma) (Vaughn 1962).

The occurrence of the Cutler Formation within the study area is very limited. The formation developed on the southwest flank of the Uncompahgre Uplift, and its outcrops are limited to south of the Gateway Fault (DeVoto 1980). Outcrops in the study area occur in Granite Creek Canyon and along the northern edge of the Dolores River drainage north of Gateway. Both areas are in the Glade Park Planning Area. The outcrops tend to be gravelly weathered slopes or somewhat competent scarps. Under extreme weathering, outcrops may resemble recent alluvium. A test of fresh rock material will reveal some degree of lithification. Inspection of a 65-acre area along Granite Creek on the Colorado-Utah border revealed no fossils (see Appendix A).

Fossil vertebrates are known from the Cutler Formation, although not from the study area or the immediate vicinity. The nearest occurrences are in San Juan County, Utah (Vaughn 1962) and Placerville, Colorado (Lewis and Vaughn 1965; Baird 1965). A significant point is that at least some of the localities are from conglomeratic beds. As far as we were able to determine, no professional surveys have been done on the Cutler Formation north of the Dolores River, possibly because difficulty of access has limited work in this area.

Paleoenvironmental interpretations suggest an area of mudflats, prone to seasonal dessication. The coarser sediments, such as those found in the study area, were more upland in origin, deposited by braided streams where vegetation was denser (Vaughn 1962; Lewis and Vaughn 1965). Climates similar to those inferred for the deposition of the Cutler Formation are present today in the Amazon Basin of South America and in the Ganges drainage of India.

Because there are no known vertebrate fossil localities in the Cutler Formation within the study area and no fossils were found during the field survey, the potential for finding vertebrate fossils is considered low. The possibility of their occurrence, however, should be kept in mind, especially since the conglomeratic facies have proven to be productive elsewhere.

Vertebrate Fauna of the Cutler Formation in the Four Corners Region

Class: Chondrichthyes
Order: Elasmobranchii
Family: Zenacanthidae

Xenacathus aff. X. texensis
Xenacanthus sp.

Class: Osteichthyes
Order: Palaeoniscoidea
Family: Palaeoniscidae

Progyrolepis ?

Family: incertae sedis

Possibly three species

Order: Crossopterygii
Family: Osteolepidae

Ectosteorhachis aff. E. nitidus

Class: Amphibia
Order: Temnospondyli
Family: Chenoprosopidae

Chenoprosopus milleri

Family: Eryopidae

- Eryops grandis
- Eryops sp.

Family: Eryopidae ?

- Limnopus culterensis

Family: Dissorophidae

- Platyhystrix rugosus
- Broiliellus novomexicanus

Family: Zatracheidae

- Eatrachys serratus

Order: Nectridea ?

- a questionable nectridean

Order: Microsauria

- genus near Puntylus

Class: Reptilia
Order: Cotylosauria
Family: Seymouriidae

- new unnamed genus and species

Family: Diadestidae

- Diadectes sanmiquelensis
- D. lentus
- Diadectes sp.
- cf. Brachyductylopus

Family: Romeriidae

- indeterminate genus

Family: Limnoscelidae

- Limnosceloides brachycoles
- Limnoscelops longifemur

Family: Captorhinidae

- Puercosaurus obtusidens
- genus indeterminate

Order: Synapsida
Family: Ophiacodontidae

- Ophiacondon cf. O. navajovicus
- O. mirus
- Ophiacondon sp.

Family: Varanopsidae

- near Aerosaurus

Family: Sphenacodontidae

Spheracondon ferox
S. cf. ferocior
Cutleria wilmarthi

Family: Nitosauridae

Mycterosaurus smithae

Family: Edaphosauridae

Edaphosaurus novomexicanus

(From Baird 1965; Langston 1953, 1966; Lewis and Vaughn 1965; and Vaughn 1962.)

MESOZOIC ERA

Triassic Period

Chinle Formation

The Chinle Formation consists of brick-red shales interbedded with thin sandstones and containing some conglomeratic lenses. A late Triassic deposit approximately 210 ma (MacLachlan 1972), the Chinle lies unconformably on the Precambrian basement or on the Late Paleozoic Cutler Formation. Sediments are non-marine in origin. The source area was more distant than that for the Cutler Formation and, as a result, the sediments are finer, deposited by meandering streams (ibid.). The Chinle Formation tends to form gentle slopes except just below the Wingate Sandstone where outcrops are more vertical. Exposures are recognizable from great distances because of the diagnostic brick red color.

With exposures occurring over most of the Uncompahgre Uplift, the Chinle is much more extensive in the study area than is the Cutler. Outcrops are confined to south of U.S. Highway 50, within the Glade Park Planning Area.

Forty acres of Chinle were surveyed southwest of Glade Park (see Appendix A). No vertebrate fossils were found although invertebrate tracks were common on bedding planes of the sandstone layers.

The climate at the time of deposition of the Chinle is assumed to have been tropical or warm subtropical. Forests were prevalent, as witnessed by the Petrified Forest in the Chinle Formation of Arizona. Fish populations were adapted to quiet waters similar to the habitat of modern catfish. The tetrapods were mostly bulky, slow-moving types, although two bipedal reptiles were probably swift runners (Colbert 1972).

We have been unable to locate any professional surveys of the Chinle

Formation within the study area. It is probable that geologists or paleontologists have looked for fossils in the region, but there does not appear to have been a planned reconnaissance for fossil vertebrates. There are no known localities in the study area and our field survey located no vertebrate fossils. However, from the abundance of invertebrate tracks and trails in the study area and the occurrence of vertebrate remains near the town of Bedrock, it is likely that fossil vertebrates do occur within the study area. Elsewhere, the Chinle has produced a well-known vertebrate fauna, primarily from Arizona, Utah, and Montrose County, Colorado (Colbert 1972; Schaeffer 1967).

Vertebrate Fauna of the Chinle Formation

Class: Osteichthyes
Order: Palaeonisciformes
Family: Palaeoniscidae

Turseodus dolorensis

Family: Redfieldiidae

Cionichthys dunklei
Lasalichthys hillsi
Synorichthys stewarti

Family: incertae sedis

Tanaocrossus kalliokoskii

Order: Semionotiformes
Family: Semionotidae

Semionotus sp.
Hemicalypterus weiri

Order: Crossopterygii
Family: Coelacanthidae

Chinlea sorenseni

Order: Dipnoi
Family: Ceratodontidae

Ceratodus

Class: Amphibia
Order: Temnospondyli
Family: Metoposauridae

Metoposaurus

Class: Reptilia
Order: Thecodontia
Family: Erpetosuchidae

Hesperosuchus agilis

Family: Aetosauridae

Desmatosuchus
Typothorax

Family: Phytosauridae

Phytosaurus
Rutiodon

Order: Saurischia
Family: Podokesauridae

Coelophysis

Order: Therapsida
Family: Kannemeyeriidae

Placerias

(From Colbert 1952, 1972; and Schaeffer 1967.)

Wingate Sandstone

The Wingate Sandstone is a buff to reddish, fine-grained well-sorted sandstone. It is massive to highly cross-bedded. The unit lies conformably on the Chinle Formation and is Late Triassic in age (200 ma). Sediments are non-marine but, unlike the underlying alluvial beds, are wind-deposited (MacLachlan 1972).

The outcrop pattern is the same as that of the Chinle Formation discussed above. The Wingate Sandstone forms vertical, or nearly vertical cliffs and monoliths such as Independence Monument in Colorado National Monument.

Approximately 40 acres of the Wingate were surveyed in the Colorado National Monument (see Appendix A). Because of the vertical outcrops, field surveys are more or less confined to the upper and lower limits of the formation where less resistant rock types allow access. No fossils were located during the survey. Fossils from the Wingate are rare. The only reported occurrence in the region is by Bunker (1957), who noted theropod footprints near Bedrock in Montrose County, Colorado. The tracks appear to have been made by a coelurosaur, a small bipedal dinosaur.

Based upon this scant fossil evidence, little can be said about the paleonenvironment. Interpretations based on geology indicate a shift from a fluvially dominated environment to a more arid one.

Apparently, there have been no professional paleontological surveys done and there are no known localities within the study area. Eolian deposits seldom preserve fossils: the abrasive nature of windblown sand quickly erodes any bones before burial and fossilization can occur. For this reason, the potential for locating vertebrate remains in this unit is very low. The discovery of any fossils would be largely a matter of chance.

Kayenta Formation

Thin-bedded, buff and red, fine to coarse sandstones dominate the Kayenta Formation, although there are minor interbedded siltstones and shales and occasional lenses of mudball conglomerates. The Kayenta lies conformably on the Wingate Sandstone. Its age is somewhat problematic, however, because of the scarcity of fossils not only in the Kayenta itself but also in the under- and overlying units. The age of the Kayenta is thought to be late Triassic and/or early Jurassic (190-195 ma): Lewis et al. (1961) lean toward a Late Triassic age based on the fossil evidence, while Wells (1954) favors a Jurassic age.

The sediments reflect a return to a fluvial environment, more like that which prevailed during the deposition of the Chinle Formation than that of the intervening Wingate Sandstone. The source area was to the east with the rivers and streams flowing toward the southwest (MacLachlan 1972).

Outcrops occur in the same areas as those of the Chinle and Wingate. Usually, they form a caprock on outcrops of Wingate Sandstone or occur as breaks in the slope between the more resistant Wingate and Entrada Sandstones.

Fifteen acres of Kayenta were surveyed, covering the entire thickness of the unit (see Appendix A). Although no fossils were discovered, it should be noted that the nature of the bedding makes it possible that footprints could be preserved. In addition, the presence of mudball conglomerates increases the potential for vertebrate fossils.

No record of professional surveys and no known fossil localities were found for the vicinity. The closest reports of vertebrate fossils in the Kayenta Formation are from northern Arizona and southern Utah (Lewis et al. 1961; Wells 1954). The resource potential is therefore considered low.

Vertebrate Fauna from the Kayenta Formation

Class: Reptilia
Order: Crocodilia
Family: Protosuchidae

Protosuchus richardson

Order: Saurischia
Family: Megalosauridae

Megalosaurus wetherill

Order: incertae sedis

dinosaur tracks

Order: Therapsida
Family: Tritylodontidae

unnamed new genus and species

(From Lewis et al. 1961; and Wells 1954.)

Jurassic Period

Entrada Sandstone

The Entrada Sandstone is similar to the Wingate -- well-sorted, massive to cross-bedded, and fine-grained. Its color is brick red when weathered, buff to pink when fresh. The Entrada lies conformably on the Kayenta Formation. The sediments are eolian in origin and, based on stratigraphic position, are thought to be Middle Jurassic, 153-160 ma (Berman et al. 1980).

The occurrence of the Entrada Sandstone coincides with that of the underlying Triassic units discussed previously. Outcrops are vertical and the accessibility of the formation to surveys is limited.

Thirty acres of Entrada were surveyed in the Colorado National Monument (see Appendix A). No indications of fossils were found.

The Entrada is thought to represent a near-shore environment similar to modern beach dunes (Peterson 1972). The explanation for the lack of fossils in the Entrada is the same as that for the Wingate.

We were unable to find any references to fossils from the Entrada Sandstone, and there have apparently been no professional surveys of this unit. The potential for finding vertebrate remains in this unit is very low. The only real possiblity would be the occurrence of footprints.

Summerville Formation

The Summerville Formation consists of alternating thin, horizontally bedded grey, green, and red siltstones, cross-bedded or wavy-bedded fine sandstones which may contain discontinuous limestone lenses, and red and green shales (Berman et al. 1980; Cashion 1973). In the Grand Junction area, the Summerville is 15 to 20 meters thick and contains some very large-scale deformational structures and slumps (Berman et al. 1980; Cashion 1973). Contact with the underlying Entrada Sandstone is visually sharp and appears to be entirely conformable (Lohman 1965). Holt (1940b) maintains the sediments are of even horizontal bedding due to estuarine origin, however Berman et al. (1980) consider the thin beds to be the result of nearshore-marine deposition, as do Riggs and Farrington (1901a, 1902). Both the uniform thinness of the beds and the presence of ripple marks on some of these beds suggest deposition of the Summerville Formation in a quiet body of water (Lohman 1965). The lack of channel scour and fill within the Summerville indicates that it was probably not deposited by stream action such as that which deposited the sandstones of the overlying Morrison Formation. Sedimentation began as early as the Middle Jurassic (158 ma) and continued as late as the Upper Jurassic (150 ma) (DeVoto 1980). Although no fossils have been found in the Summerville Formation, it has been assigned to the Upper Jurassic on the basis of the fossils found in the underlying and overlying formations at the type area (Lohman 1965).

The Summerville Formation developed in the area of the Uncompahgre Uplift in western Colorado. Its occurrence in the study area is confined to the Glade Park Planning Unit south of the Colorado River; its outcrops are limited to south of the Redlands Fault (Lohman 1963). In and around the Colorado National Monument, outcrops are exposed on the south side of the Colorado River near the tops of canyon walls (see Figure 2).

Weathering of outcrops yields gentle, rolling, tan sandy slopes evincing small broken plates of shale and sandstone. Fresh exposures are found at Artist's Point in Colorado National Monument (see Summerville-2 in Appendix A), in recent road cuts, and in steeply cut drainages. Inspections of a 5-acre area at Artist's Point and a 35-acre area along Little Park Road revealed no fossils. (see Appendix A).

Several professional geological surveys have been conducted in the area. Riggs and Farrington (1901a, 1902) studied in the Summerville Formation in the Colorado National Monument, but they report no fossil occurrences. Holt (1940a, 1940b) included a study of the Summerville Formation for his Master's degree at the University of Colorado at Boulder. He was able to trace the Summerville as far east as Iola, Colorado but noted no occurrence of fossils. While studying the aquifers of the area, Lohman (1965) measured sections of the Summerville Formation, including Artist's Point which was also surveyed in this study. Lohman reports no fossil occurrence in the formation. Callison (1977) prospected the Summerville Formation at Artist's Point and observed the occurrence of gastropods, but no vertebrate fossils were found.

No fossil vertebrates have been reported from anywhere in the Summerville Formation except possible dinosaur tracks (Gal 1977). These "tracks" have supposedly been found by local rock hunters near Moab, Utah (ibid.). Since the beds are continuous, it is possible these tracks may also occur in the study area.

The paleoenvironment of the area is interpreted as being one of tropical to subtropical paludal lagoons. Some shallow, low-velocity streams were also working in the area (Lohman 1965), but nowhere do these cut deeply into the sediments. No coals or vegetal material have been found, perhaps due to a lack of dense vegetation or the presence of a reducing atmosphere (ibid.). (A wet reducing atmosphere is inferred from the red color of most of the beds. Fossils tend to disintegrate in beds of a reducing atmosphere -- this may explain the lack of fossils in the Summerville Formation.)

Due to the apparent dearth of vertebrate fossil localities in the Summerville Formation within the study area, and because no fossils were found during the field survey, the potential for discovering fossil resources is considered low.

Morrison Formation

In the Grand Junction area the Morrison Formation contains two members. The lower member of the formation, the Salt Wash Sandstone Member (often just called the Salt Wash) is characterized by white, grey, rusty-red, and buff sandstone interbedded with red, grey, and green (prominent) mudstone with thin limestone beds near the base. Above this member is the Brushy Basin Shale Member (often called the Brushy Basin) which consists of grey, pale-green, red, and light purple mudstones and siltstones; interspersed are a few lenses of grey sandstone, limestone, and conglomerate. Local thicknesses of the members are 100 to 300 feet for the Salt Wash and 200 to 300 feet for the Brushy Basin (Cashion 1973). By Grand Junction, a slight erosional unconformity occurs at the contact between the Salt Wash and the Summerville, but at Fruita, basal limestones of the Morrison are conformable with the underlying Summerville beds (Lohman 1965). Holt (1940b) considered the contact to be conformable and, on the basis of algaelike casts in a sandstone near the base of the Morrison (which Riggs and Farrington, 1901a, 1902, noted as a fine-grained brown sandstone with "peculiar honeycomb weathering"), decided that the basal beds of the Morrison are lagoon sediments deposited near the shore of the Late Jurassic/Cretaceous sea.

The base of the Salt Wash member marks the end of Jurassic marine deposition with the withdrawal of the Curtis-Sundance sea (143 ma). A period of widespread erosion followed: deposits were carried into the area from eroding mountains to the south and west by streams and flooding of the low-relief topography. Sandstones in the formation are characterized by cross-bedding, scour-and-fill structures, mudstone fragments, vegetal material, silicified wood, and fossil vertebrate elements (Berman et al. 1980), and represent braided stream channels. Mudstones represent an occasional paludal or sheet-washed floodplain environment; in these sediments "gastroliths" have been found but their association with dinosaurs is questionable (Stokes 1942).

Above the Salt Wash, the Brushy Basin Member consists of deposits similar to the Salt Wash, but which are more red. Sandstones tend to occur more frequently and are slightly more massive, perhaps due to more prevalent stream channels. Intertonguing of sandstone, mudstone, and limestone lenses occurs due to alternating stream channel, floodplain, and lake deposits. Fossil tree trunks, silicified plant material, and dinosaur skeletal elements are all abundant, especially near the top of the formation (138 ma) (Berman et al. 1980).

The swampy to arid conditions of the time supported a variety of animals in differing microenvironments. Fauna from the Morrison include fresh water fish, small amphibians, turtles, crocodiles, lizards, flying dinosaurs, large carnivorous dinosaurs, small to gigantic herbivorous dinosaurs, bird-hipped dinosaurs, birds, and some of the earliest known mammals found in the Western Hemisphere. All of these forms were living in environments close to water, and the mammals tend to be found in clay-ball and mudstone conglomerates, perhaps indicative of ancient ground surfaces with soil development (paleosols).

Plants in the form of shrubs and trees were fairly lush in places, but were not coal-forming. Large trees related to the modern day sequoia tree formed forests in several regions. Fern-like cycad trees and palms were also abundant. These fossils are often found in stream-deposited sandstones.

Molluscs and gastropods are known from lake and other wet environments. It is doubtful, though, that these invertebrates were a food source for the megafauna of the time.

The Morrison Formation outcrops in both planning units in the study area. In the Mount Garfield Planning Area, the Morrison is limited to a set of exposures along the north side of the Colorado River (on the north side of the Uncompahgre Uplift). It occurs only in the Grand Valley and outcrops as sandstone-capped hills. Outcrops in the Glade Park Planning Area are found south of the Colorado River in and around the Colorado National Monument area. These outcrops are higher in elevation, but are still capped with layers of resistant sandstone. Survey areas include the Black Ridge area on the west side of Colorado National Monument, the contact area of the two members off of Little Park Road, and a small hill near the Fruita Paleontological Area (see Appendix A).

Nineteen localities are known from the study area (see Appendix B). Four are known from the Mount Garfield Planning Unit, fifteen from the Glade Park Planning Unit. Of the formations in the study area, the Morrison is by far the most fossiliferous. Professional field work has been conducted in the area since Elmer S. Riggs of the Field Museum of Natural History uncovered the remains of a Brachiosaurus altithorax in 1900.

In spring of 1899, Elmer S. Riggs, Assistant Paleontologist at the Field Museum of Natural History in Chicago, learned of vertebrate fossil occurrence in the Grand River Valley. Correspondence with Dr. S. M. Bradbury, President of the Western Colorado Academy of Science, revealed that dinosaur fossils had been known locally since 1885, but were collected as "curios", and word of their discovery had not yet spread (Riggs and Farrington 1901a, 1902).

The following spring, in 1900, a Field Museum expedition was organized and sent to the region (of the study area) for the purpose of collecting fossils from the Jurassic formations. After three months of field work, the crew had collected a foreleg of a large sauropod dinosaur, Camarasaurus (Morosaurus) grandis, several Camarasaurus grandis limb bones and vertebrae, and the type specimen of Brachiosaurus altithorax (Armstrong 1980; Bureau of Land Management 1977; Callison 1977; Holt 1940b; Lohman 1965; Look 1951, 1955; Pearl 1958 and 1969; Powers 1977; Riggs 1901, 1903a, 1904; Riggs and Farrington 1901a, 1901b, 1902; Skiff 1901, 1909; Van Couvering and Robinson 1980; Young and Young 1977).

Riggs and Farrington (1901b) discovered the forelimb of a Camarasaurus grandis dinosaur in the green mudstone beds of the Morrison Formation somewhere near the end of the Serpents Trail in Colorado National Monument. The exact locality for this find was never recorded, and no fossils have since been found in that area. Bones of another Camarasaurus grandis were found near the Colorado National Monument (Riggs and Farrington 1901a, 1901b, and 1902), but no records exist as to the area of their discovery in the Grand River Valley.

Of world importance at the time was the uncovering of remains of the largest land animal yet discovered, Brachiosaurus altithorax (Riggs 1903a). In situ bones of this individual were discovered by H. W. Menke in their relative places in a sandstone layer on the south side of Riggs Hill just west of Grand Junction (see Appendix B). The bones consisted of a humerus, coracoid, seven thoracic and two caudal vertebrae, a femur, ilium, sacrum, ribs, and other bones. Riggs assigned this find to the new genus Brachiosaurus on the basis of its large size and its being the only dinosaur with a humerus longer than its femur (ibid.).

In the spring of 1901, Elmer Riggs and H. W. Menke returned to the area for a second field season. On the southeast side of what is known locally as Dinosaur Hill, in a sandstone layer, two-thirds of a large sauropod dinosaur, Apatosaurus (Brontosaurus) excelsus was found (see Appendix B) (Armstrong 1980; Callison 1977, Lohman 1965; Look 1951 and 1955; Pearl 1958 and 1969; Riggs 1903b, 1903c; and Skiff 1909). Unfortunately, the front part of the skeleton had been exposed for many years and had weathered away. Riggs and Menke tunneled about twenty feet into the hillside from two different points to search for displaced caudal (tail) vertebrae. Elements of this large skeleton were plaster jacketed, taken by wagon to the Colorado River, ferried across, and taken by train to Chicago (Look 1951 and 1955). A broken and healed rib of this specimen has since been studied by Moodie (1923).

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In 1938, ceremonies were held at both Riggs and Dinosaur Hills to commemorate the finding of these important specimens (ibid). An Italian stonemason (name since forgotten) constructed cairns on each site. A brass plaque inscribed with "*Brachyosaurus*, the giant dinosaur, first known skeleton discovered here in 1900 by Elmer S. Riggs and preserved in the Field Museum Chicago" was inserted in the cairn on Riggs Hill. On Dinosaur Hill, a plaque stating "Discovered here, 1901, a giant *Apatasaurus* skeleton by Elmer S. Riggs, now mounted in Field Museum Chicago" was inserted in the other cairn. Both plaques were paid for by Al Look, Elmer S. Riggs, and the Grand Junction Chamber of Commerce (Alfred Look, personal communication).

For his Master's thesis at the University of Colorado at Boulder, Lee Edward Holt studied the Summerville and Morrison Formations of the Grand Valley area (Holt 1940a and 1940b). At Riggs Hill in 1937, he found three *in situ* skeletons forty-two feet above Riggs' *Brachiosaurus altithorax* quarry and fifty yards around the hill to the northwest (Holt 1940b). Holt was encouraged to prospect the area by a local collector, Ed Hansen, who showed him a few stegosaur caudal vertebrae (ibid.).

Holt uncovered partial skeletons of *Brachiosaurus altithorax* (?) and *Antrodemus valens* (?) and a complete skeleton of *Stegosaurus marsh* that was in an excellent state of preservation (Holt 1940b; Look 1951, 1955, and personal communication). These skeletons were all in a sandstone layer approximately twenty feet wide by sixty feet long around which a fence with a gate was constructed (which still stands).

Holt studied, measured, and described these fossils *in situ*, hoping that the area would be incorporated into the boundaries of the nearby Colorado National Monument. Insufficient money was raised to purchase the land, however, and the skeletons lay prey to local bone hunters (ibid).

During this period, the quarry was visited by Brian Patterson and Quinn of the FMNH. In a last effort to preserve the skeletons intact, Al Look and others tried to convince the Grand Junction Chamber of Commerce to build a "jail" over the site, but again sufficient funds could not be raised. Finally, the fossils were covered with nearby talus debris (ibid). Bone hunters were unabated, however, and continued to vandalize the site. In about 1960, a group from a local church came to the quarry and broke out the remaining fossil bone for "souvenirs" (Al Look, personal communication).

In 1965, S. W. Lohman conducted geologic mapping in the Morrison Formation of the study area for the U.S.G.S. He noted the quarries previously mentioned (Lohman 1965) but made no note of fossils.

Farish A. Jenkins, Jr., and a crew from the Agassiz Museum of Comparative Zoology at Harvard spent a few days in the area around Fruita in 1976 in search of Mesozoic mammal fossils. They noted the occurrence of large dinosaur bones in the area, but made no significant finds of small vertebrates.

Lance Eriksen, Curator of Paleontology at the Museum of Western Colorado, conducted paleontological investigations in the study area starting in 1976. He worked with the abundant dinosaur remains exposed southwest of Fruita, the Fruita Paleontological Area (see Appendix B), and was instrumental in bringing the area to light as being paleontologically significant. In 1976, he found a partial skeleton and well-preserved skull of the meat-eating dinosaur Ceratosaurus nasicornis. This skull is the second skull found (and best preserved) of this genus and species in the Morrison. Eriksen has also collected a Brachiosaurus femur, Apatosaurus (?) tooth, several bones and a vandalized maxilla of the meat-eating dinosaur Antrodemus valens, and turtle and crocodile skeletal elements. He has done much work on interpreting the sediments of this area at the contact of the Salt Wash and Brushy Basin Members of the Morrison Formation (Eriksen 1976, 1977).

One of the most significant finds ever made in the area was the discovery of mammal fossils at the Fruita Paleontological area by George L. Callison and crew of the California State University at Long Beach (Clemens et al. 1979). In 1976, the area was found to have red beds containing bones of small animals. Primitive shrew-sized mammal teeth and bones have since been found there, representing the Orders Multituberculata, Triconodonta, Symmetrodonta, and Eupantotheria. Many of these finds are of new, undescribed genera and species such as Priacodon, new species (Rasmussen and Callison, 1981, in press) (see Figure 4). Small and large reptiles representing turtles, crocodiles, lizards, meat-eating dinosaurs, bird-hipped dinosaurs, and stegosaurs have been found there as well. Many of these specimens are articulated and may represent an ancient soil horizon (Callison 1976, and personal communication).

Currently, the Grand Junction District of the Bureau of Land Management has control of the Fruita Paleontological area. Through the efforts of John Crouch, District Archaeologist, and others, this land has been set aside as a paleontological resource area. In 1977, a meeting was held in Grand Junction with leading paleontologists from around the nation to discuss the potential and significance of the area (Bureau of Land Management 1977; Powers 1977).

In 1977, George L. Callison and crew from the California State University at Long Beach also conducted a fossil resource inventory of the Colorado National Monument (Callison 1977). They found twelve vertebrate-fossil producing localities in the Morrison Formation. Mainly dinosaur bones and bone scrap were found, but were largely unidentified due to the no-collections policy of the National Park Service (ibid.).

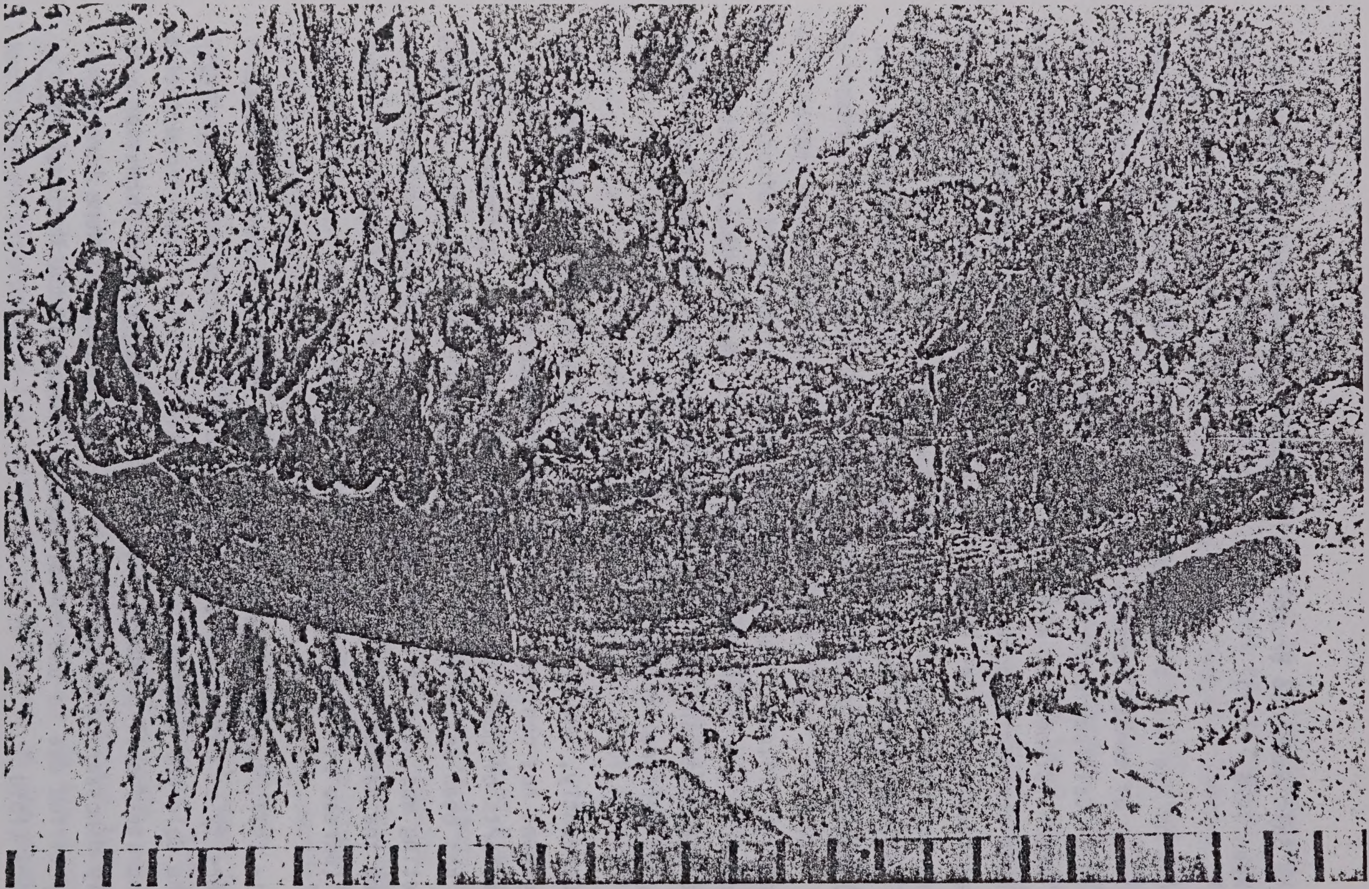

Figure 4. Left mandible (jaw) of a new species of triconodont mammal (LACM 120451) (Genus Priacodon) found in 1979 at the Fruita Paleontological area (Rasmussen and Callison 1981) (with permission of authors). Scale at bottom is in millimeters.

Prior to this report, field work was conducted in the areas of Riggs and Dinosaur Hills by the authors (Armstrong 1980). Bone scraps were noted at each locality but no diagnostic elements were found (ibid.).

For the purposes of this report, approximately one-hundred and fifty acres of Morrison exposures were surveyed (see Appendix A). Two new localities producing fossil vertebrates were discovered (see Appendix B). The new locality at Black Ridge (8050-5 and 8050-5a) produced five teeth (see Figure 5) and a number of bone fragments. The other locality is of note due to the presence of small bone fragments and its stratigraphic and lithological equivalency to the Fruita Paleontological area.

One locality (8050-3, Appendix B) on the west side of Dinosaur Hill was pointed out by Lance Eriksen (personal communication). Here, a resistant sandstone layer occurs approximately ten meters stratigraphically above the *Apatosaurus excelsus* quarry. One boulder from this sandstone has fallen down the hill, revealing a large sauropod humerus mold (see Figure 6). This area holds potential for finding further bone in the sandstone.

Because of the abundance of fossils in the Morrison Formation, and especially because of their occurrence in the study area, this formation is considered to have the highest potential of all the formations within the study area for producing vertebrate fossils. Significant dinosaurs and early mammals have been found and it is extremely probable that other scientifically important specimens will be located.

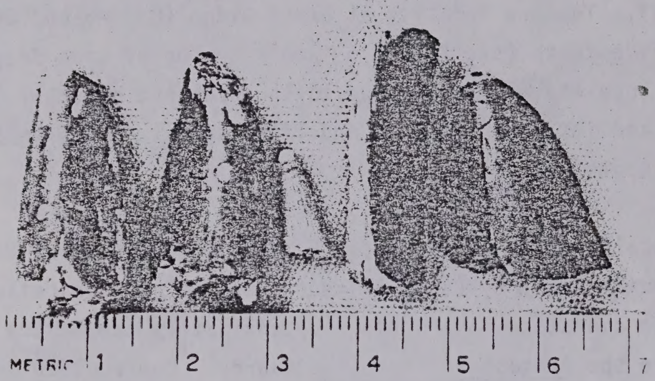

Figure 5. Teeth found at Black Ridge locality. (From left to right: two Antrodemus valens anterior teeth, 1 crocodilia tooth, 2 Ceratosaurus nasicornis tooth fragments).

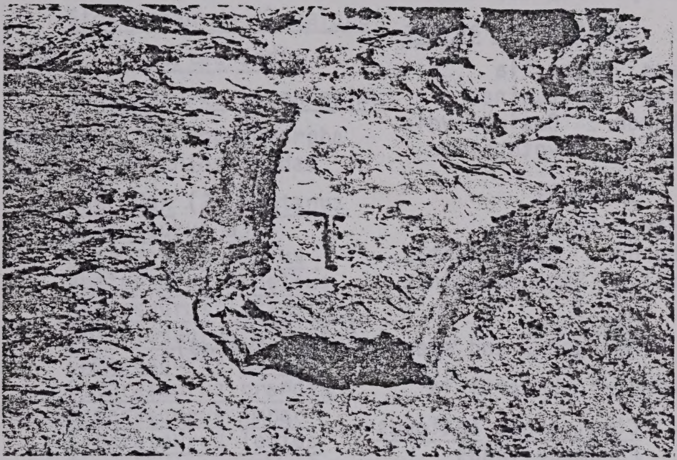

Figure 6. Looking east at large sauropod humerus cast (left of hammer) in boulder. Boulder is near old highway on the west side of Dinosaur Hill.

Vertebrate Fauna from the Morrison Formation
(classification system from Romer 1974)

Class: Osteichthys

Ceratodus guntheri

Class: Amphibia
Order: Anura
Suborder: Aglossa ?
Family: Pipidae ?

Eobatrachus agilis

Class: Reptilia
Order: Testudines
Suborder: Casichelydia
Family: Glyptopsidae

Glyptops

Order: Squamota
Suborder: Sphenodontia
Family: Sphenodontinae

Opisthias
New genus and species (undescribed).

Suborder: Lacertilia

Ctenіogenys antiquus
Paramacellodus

Family: Dorsetisauridae

Dorsetisaurus

Order: Crocodilia
Suborder: Mesosuchia

Goniopholis felix
Megalognathus vagans

Order: Pterosauria
Suborder: Pterodactyloidea
Family: Indeterminate

Dermodactylus Montanus
Pteraichnus saltwashensis

Order: Saurischia
Suborder: Theropoda
Family: Coelurosauridae

Coelurosaurus
Coelurus agilis
Ornitholestes fragilis

Family: Megalosauridae

Antrodemus atrox
Antrodemus ferox
Antrodemus lucaris
Antrodemus valens
Cerotosaurus nasicornis

Family: Tyrannosauridae ?

Stokesosaurus clevelandi

Family: *Incertae sedis*

Marshosaurus bicentesimus

Suborder: Sauropodomorpha
Family: Brachiosauridae

Antrodon (?) *montanus*
Apatosaurus ajax
Apatosaurus amplus
Apatosaurus excelsus
Apatosaurus laticollis
Brachiosaurus altithorax
Camarasaurus agilis
Camarasaurus grandis
Camarasaurus impar
Camarasaurus lentus
Camarasaurus robustus
Diplodocus lacustris
Diplodocus longus
Haplocanthosaurus

Family: Titanosauridae

Atlantosaurus immanis
Atlantosaurus montanus
Barosaurus affinis
Barosaurus lentus

Order: Ornithischia
Suborder: Ornithopoda
Family: Hypsilophodontidae

Dryosaurus altus
Fabrosaurus
Laosaurus celer
Laosaurus consors
Laosaurus grocilis
Nonosaurus rex
Othnelia

Family: Iguanodontidae

Camptosaurus amplus
Camptosaurus dispar
Camptosaurus manus
Camptosaurus (?) *medius*

Suborder: Stegosauria
Family: Stegosauridae

Stegosaurus armatus
Stegosaurus stenops
Stegosaurus sulcatus
Stegosaurus ungulatus

Class: Aves ?

Leopteryx priscus

Class: Mammalia
Order: Docodonta
Family: Docodontidae

Docodon affinus
Docodon crassus
Docodon striatus
Docodon superbus
Docodon victor

Order: Triconodonta
Family: Triconodontidae

Priacodon (new species)
Priacodon ferox
Priacodon grandaevus
Priacodon lulli
Priacodon robustus
Trioracodon bisulcatus

Order: Multituberculata
Suborder: Plagiaulacoidea
Family: New family

New genus and species

Family: Plagialacidae

Ctenacodon laticeps
Ctenacodon serratus
Psalodon fortis
Psalodon (?) *marshi*
Psalodon potens

Order: Symmetrodonta
Family: Spalacotheriidae

Amphidon superstes
Aploconadon comoensis
Phascolodon gidleyi
Tinodon aequicyarius
Tinodon bellus
Tinodon lepidus

Order: Eupantotheria
Family: Paurodontidae

Araedon intermissus
Archaeotrigon distaymus
Paurodon valens
Tathiodon agilis

Family: Dryolestidae

Amblotherium debilis
Amblotherium gracilis
Dryolestes priscus
Euthlastus coediformis
Kepolestes coloradensis
Laolestes eminens
Laolestes grandis
Laotestes ucrax
Melanodon arcuatus
Melanodon gracilis
Melanodon goodrichi
Melanodon (?) *humilis*
Melanodon obtuses
Melanodon osborni
Melanodon oweni
Miccyclotyranus minimus
Pelicopsis dubius

(From Barry 1976; Callison 1980, and personal communication; Clemens, et al. 1979; Galton and Jensen 1979; Jensen and Ostrom 1977; Madsen 1974, 1976a, and 1976b; Madsen and Stokes 1977; Marsh 1896; Prothero and Estes 1980; Rasmussen and Callison 1981; Riggs 1903a; Romer 1974; Simpson 1929; and Stokes 1957.)

Cretaceous Period

Burro Canyon Formation

The Cretaçeous Burro Canyon Formation consists of white and grey fine to coarse-grained sandstones interbedded with mudball conglomerates, purplish siltstone, shale, mudstone, and thin beds of limestone. Thickness in the area varies from a few feet to one-hundred twenty-five feet (Cashion 1973). Contact with the underlying Morrison Formation appears to be entirely conformable and visually sharp in the study area. A continental origin is inferred for the sediments: the siltstone, shale, and sandstone beds reflect stream deposition, while the lenticular limestone beds were probably deposited in shallow lakes (Lohman 1965). Sedimentation began in the Early Cretaceous (113 ma) and continued for a short time (111 ma) (Berman, et al. 1980).

Within the Burro Canyon, Lohman (1965) reports the occurrence of plant remains, fresh-water invertebrates, and reworked Paleozoic invertebrates. As far as can be ascertained, the only vertebrates reported from this formation were found within the study area. These fossil bone molds occur in a mudball conglomerate lens near the base of the formation.

The Burro Canyon Formation occurs in both the Mount Garfield and Glade Park Planning Units. In the Mt. Garfield Planning Unit, it outcrops as caprock on Morrison Formation hills and in a wide area north of the Colorado River in the southwesternmost extension of the planning unit. Within the Glade Park Planning Unit, it outcrops as caprock along the south side of the Colorado River, with large exposures occurring in the Colorado National Monument area and in the eastern half of the planning unit (see Figure 2).

Outcrops tend to weather as whitish sandstone cliffs and ledges with large blocks breaking off on planes of weakness such as at conglomeratic lenses. Forty-five acres of exposures were surveyed at two places; one place was on the east side of Colorado National Monument and the other was at a locality in Unaweep Canyon near the southern edge of the Glade Park Planning Unit (see Appendix A). Inspection of conglomeratic facies at the latter area revealed a large boulder in which were a number of fossil bone molds including a theropod dinosaur femur mold (8050-20) (see Figure 7).

As far as can be ascertained, no professional surveys have been done on the Burro Canyon of the area. The fossiliferous boulder mentioned above is the only known occurrence of fossil vertebrates in the formation. Because of the occurrence of this vertebrate fossil locality within the study area, a potential for discovering vertebrate fossil resources exists. The conglomeratic surfaces are expected to be the most productive beds and more fossils may be found if any activity occurs where sandstone blocks are removed.

Vertebrate fauna from the Burro Canyon Formation

Class: Reptilia
Order: Saurischia
Suborder: Theropoda
Genus indeterminate

Dakota Sandstone

The Dakota Sandstone consists of friable yellowish-brown and grey quartzitic sandstone and conglomeratic sandstone with interbedded grey to black carbonaceous shale. Plant impressions are common within basal conglomerates that are locally present. Thickness in the area ranges from 100 - 200′ (Cashion 1973). Contact with the underlying Burro Canyon Formation is unconformable due to an erosional surface. Sediments of the Dakota Sandstone are subtropical fluvial (stream) deposits with some coal-forming coastal swamps or lagoons. The upper part of the formation appears to have been floodplain, stream channel, and

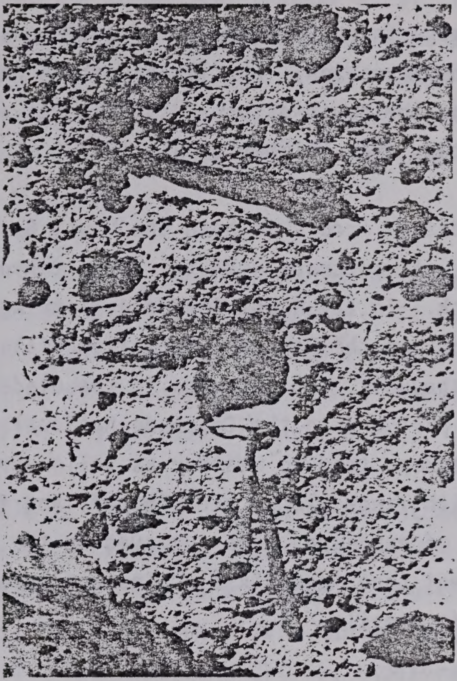

Figure 7. Burro Canyon Formation boulder with bone molds. Theropod dinosaur femur mold is above center of photo.

pond deposited. These near-shore deposits accumulated as the Mancos Sea gradually encroached (Fisher et al. 1959, Lohman 1965). Sedimentation began in the Lower Cretaceous (100 ma) and continued for three million years (97 ma) (Berman et al. 1980).

Lohman (1965) reports the occurrence of coal beds (the result of plant remains) in the formation. Fossils have been reported in the Dakota Sandstone from the southwestern United States, but all at a great distance from the study area (Fisher et al. 1959).

The Dakota Sandstone occurs in both the Mount Garfield and Glade Park Planning Units. It outcrops with the Burro Canyon Formation as cliff-forming caprock. In the Mount Garfield Planning Unit it occurs extensively as caprock on the Morrison Formation hills in the southwestern portion of the unit. It outcrops in the Glade Park Planning Unit in the eastern part and in the Colorado National Monument area (see Figure 2). Outcrops tend to weather as yellow-brown sandstone cliffs and ledges with large blocks breaking off and forming blocky talus slopes. Five acres of exposures were surveyed on the east side of Colorado National Monument (see Appendix A). Inspection of sandstone beds at this area revealed no fossils.

No professional surveys have been conducted in the Dakota Sandstone within the study area, nor in the surrounding region. Fossils occur occasionally in the formation, but are fairly rare finds. A potential for their occurrence in the study area therefore exists but, because of the weathered nature of outcrops, the expectation of finding such is low.

Mancos Shale

The Mancos Shale consists of dark-grey to black soft shale with thin sandstone beds at various horizons. Large crystals of barite and calcite occur in the sandstones locally. Thickness in the area is about four thousand feet (Lohman 1965). Contact with the underlying Dakota Sandstone is conformable and roughly gradational, with some intertonguing of the formations (Fisher et al. 1959). Sediments of the Mancos Shale are accumulations of sand and mud from coastal areas during the transgression of the Mancos Sea (Lohman 1965). Sedimentation began in the lower part of the Late Cretaceous (85 ma) and continued to the middle part of the Late Cretaceous (77 ma) (Berman et al. 1980).

Clearly of marine origin, the Mancos Shale contains marine fossils, mostly invertebrates, at many places. It has been suggested that the Mancos was deposited as mud in the shallow water of the Late Cretaceous sea beyond the sand-mud transition line (Robert G. Young 1973, and personal communication).

The Mancos Shale is exposed only in the Mount Garfield Planning Unit of the study area. Exposures occur between the Colorado River to the south and the top of the Book Cliffs to the north (Figure 2). In the Grand Valley, the lower and middle Mancos is generally highly eroded and vegetated. Near the Book Cliffs, exposures are excellent, with bedded areas still evident. Outcrops tend to weather as grey to brown clays, forming low rolling hills. Further up in the section, thin, platelike beds are exposed in drainages and steeply-eroded cliffs. About 190 acres of exposures were surveyed in the area north of Interstate 70.

The earliest recorded account of field work in the area is that by D. Jerome Fisher, Charles E. Erdmann, and John B. Reeside, Jr. of the United States Geological Survey (Fisher et al. 1959). At two areas of the Mancos (one 6 miles north of Grand Junction, the other 2 miles north of Whitewater), fish remains were found. Exact locations are not known for these specimens, nor have genus and species identifications been made (ibid.) (see Appendix B).

Robert G. Young (personal communication), geologist at Hunt Oil Company, has found vertebrate fossils in the Mancos Shale. He reports shark teeth and fish vertebrae occurring in patchy areas along the base of the Book Cliffs.

In the early 1960s, a six-foot long Xiphactinus fish was discovered in the Mancos Shale to the east of the study area (Don Lindsey personal communication) (see Figure 8). The exact locality is unknown for this find, however, which is currently in storage at the Denver Museum of Natural History. Preservation within the Mancos is extremely good, with fossilization being much better than that of the equivalent Pierre Shale in eastern Colorado (Cockerell 1919).

At an area north of Fruita, footbones of a duckbill dinosaur (Hadrosaurus ?) were found in the late 1960s. These specimens were eventually given to the Denver Museum of Natural History (see Figure 9). Locality data for this specimen was not recorded but, several years ago, a local rancher showed Lance Eriksen (MWC) the hill from which the dinosaur bones came (Lance Eriksen, personal communication). Efforts to relocate the area of this find were made by the authors, and the most likely location has been plotted (see Appendices A and B).

In the 1970s, Lance Eriksen (MWC) prospected for fossils in the Mancos Shale of the Book Cliff area. Near Mt. Garfield, he found possible mosasaur (marine reptile) stomach contents consisting of gastroliths (stomach stones), fish vertebrae, a possible hip bone, and a possible mosasaur tooth (ibid.).

A student of Jim Johnson, Geologist at Mesa College, found possible plesiosaur (larger marine reptile) vertebrae in the middle Mancos. These fossils have since departed with the student and the exact locations of the finds could not be remembered (Jim Johnson, personal communication). Possible areas for the fossil finds were

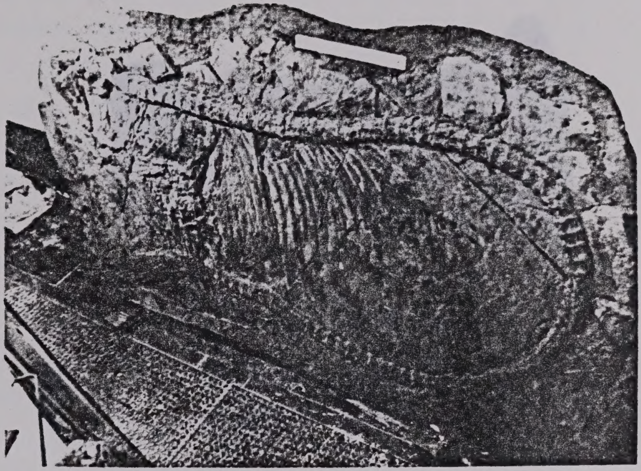

Figure 8. DMNH *Xiphactinus* fish from the Mancos Shale east of the project area.

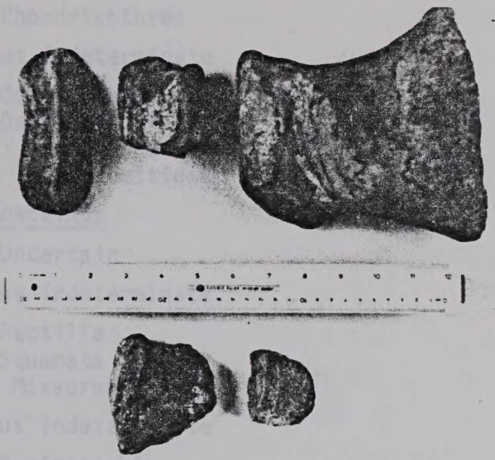

Figure 9. DMNH Hadrosaurus ? footbones. These footbones of a duckbill dinosaur must have washed into the Mancos sea from a nearby shoreline.

surveyed, but no fossils were found (see Appendix A).

Due to the verified presence of well-preserved vertebrate fossils in the Mancos Shale, a good potential exists in the area for further discoveries. Fossils are more likely to be found near the Book Cliffs due to the relative freshness of exposures.

Vertebrate Faunal List for the Mancos Shale

Class: Chondrichthyes
  Genus indeterminate

Class: Osteichthyes
Order: Osteoglossiformes
Suborder: Ichthyodectoidea
Family: Ichthyodectidae
  Xiphactinus
Order: Uncertain
  Genus indeterminate

Class: Reptilia
Order: Squamata
Family: Mosaurus ?
  Genus indeterminate
Order: Ornithischia
Suborder: Ornithopoda
Family: Hadrosauridae ?
  Genus indeterminate
Order: Sauropterygia
Suborder: Plesiosauria ?
Family: Undetermined
  Genus indeterminate

(From Fisher et al. 1959; and personal communications with Lance Eriksen, Jim Johnson, and Don Lindsey.)

Sego Sandstone

The Sego Sandstone is the lowest formation in the Mesa Verde Group. It consists of buff and light-grey fine-grained sandstone and grey shale. Thickness in the area varies from a few feet to three hundred feet, with eastward thinning (Cashion 1973). Contact with the underlying Mancos Shale is conformable. Sediments of the Sego Sandstone are of marine and fresh water origin. Sedimentation occurred in a shallow sea, near-shore environment during the Late Cretaceous (77 ma).

Fresh water and marine fossils have been found in the formation, but it is unspecified as to whether they are vertebrates or invertebrates (Fisher et al. 1959).

The formation outcrops in the study area only in the Mount Garfield Planning Unit. Steep exposures occur at the top of the Book Cliffs. Outcrops tend to weather as white to tan massive sandstones; steep talus slopes occur below exposures. Five acres of Sego Sandstone exposures were surveyed in the northern portion of the project area (see Appendix A). No fossils were identified.

Because vertebrate fossils have not been directly reported from the formation, and because of the steepness of its outcrops, the Sego Sandstone holds little potential for the occurrence of vertebrate fossil remains within the study area.

Mount Garfield Formation

The Mount Garfield Formation consists of buff and grey fine- to medium-grained sandstone and grey shale. Coal occurs in minor amounts in the upper part, but is considerably more abundant in the lower part. Thickness of the formation varies in the area from 50 to 300 feet (Cashion 1973). Contact with the underlying Sego Sandstone is completely conformable.

The sediments of the Mount Garfield Formation were deposited in the Lake Cretaceous (77 ma) and represent regression of the Cretaceous seas.

The environment of deposition was extremely variable, being marine, brackish, and fresh water at various times. Although somewhat similar to the Dakota Sandstone, the Mount Garfield contains a greater number of coal beds, indicating that the paludal environment was considerably more extensive during deposition of the latter.

Fresh water and marine fossils have been found in this formation (Fisher et al. 1959). Dinosaur bones, dinosaur tracks, and gastroliths have been reported from coal mines near the area (Don Lindsey, personal communication).

Within the study area, the formation outcrops only in the Mount Garfield Planning Unit. Steep exposures occur at the top of the Book Cliffs. Outcrops tend to weather as tan to brown sandstones with interspersed coal beds. Steep talus slopes occur below the exposures. Five acres of Mount Garfield Formation exposures were surveyed in the north extension of the project area (see Appendix A). No fossils were found.

Since vertebrate fossils have been recovered from the coal beds outside the study area, there is a possibility of finding fossils within the study area. The potential for the occurrence of vertebrate fossils is considered good.

Vertebrate Fauna from the Mount Garfield Formation

Class: Reptilia
Order: Saurischia
Family: Undetermined
Genus indeterminate

(From Don Lindsey and Peter Robinson, personal communication.)

Hunter Canyon Formation

The Hunter Canyon Formation consists of buff and grey medium and coarse-grained sandstone (cliff-forming) and grey to greenish-grey shale. Local thickness varies from 375 to 1400 feet (Cashion 1973). Contact with the underlying Mount Garfield Formation is conformable and visually sharp. The sediments have produced no fossils, and this Late Cretaceous (76 ma?) formation is largely undated (Berman et al. 1980).

Mostly continental in formation, the Hunter Canyon represents the last deposits related to the homogeneous environment of the Late Cretaceous inland seas. The formation is dominantly fluvial.

The Hunter Canyon outcrops only in the northern tip of the Mount Garfield Planning Unit. As with the other, previously mentioned formations of the Mesa Verde Group, steep exposures occur at the top of the Book Cliffs.

Outcrops tend to weather to form benches or terraces. Twenty-five acres of such exposures were surveyed in the north extension of the project area (see Appendix A). No fossils were identified.

Due to the lack of recorded fossil findings and the rugged nature of the exposures, the potential for finding fossils in the Hunter Canyon Formation within the study area is considered low.

CENOZOIC ERA

Tertiary Period

DeBeque Formation (a.k.a. Wasatch Formation)

The DeBeque Formation is a series of interbedded, variegated mudstones, sandstones, and siltstones. Colors vary among brick red, tan, white, and purple. The formation rests unconformably on the Hunter Canyon Formation and represents the first extensive continental deposits following the retreat of the Cretaceous seas. The sediments are stream, floodplain, and swamp deposits. To the east, where the formation is thicker, the age of the sediments is from late Paleocene (54 ma) to middle Eocene (47 ma). The name "DeBeque Formation" is used in all papers dealing with the fossil vertebrates of the area; the name "Wasatch Formation" is found on geologic maps. The term Wasatch has been applied to all early Eocene variegated beds from New Mexico to Canada. Its usage does not take into account the individual characteristics of formations deposited in basins, but describes these deposits as one continuous sheet over a large area.

The outcrop pattern of the DeBeque Formation is very limited in the study area. Because of erosion and the structural restrictions of the Piceance Creek Basin, the only outcrops are in the northernmost portion of the Mount Garfield Planning Area, along the upper portions of the Salt Wash drainage. Exposures are usually moderate slopes with sparse or no vegetation; small patches of "badlands" are common. The interbedded resistant sandstones and soft mudstones and the bright colors make exposures easily recognizable.

Thirty acres of DeBeque Formation were surveyed in the upper reaches of Salt Wash (see Appendix A). No fossils were discovered during the field survey.

Fossil vertebrates are common in the DeBeque Formation; collections at FMNH, UCM, CM, and MWC attest to this. Localities are reported from Mesa north to DeBeque, east to Silt and north to Meeker. An estimate of the number of specimens collected would be in excess of 3000.

Professional surveys have been made in the vicinity, although not in the study area. During the late 1930s and early 1940s, Bryan Patterson collected extensively for FMNH. The Carnegie Museum collections were made by Earl Douglas around 1903 and Leroy Kay in the 1950s. The MWC collections were made in the 1960s. The UCM collections were made during the late 1970s and continue to the present by the P.I. of this report.

Fossils, while common in the area east of DeBeque, become more scarce to the west. Here the formation thins as it nears the Douglas Arch. Lithologically the beds are comparable but perhaps environmentally, fossilization was not favored to the west.

The types of fossils found indicate a moist tropical to subtropical environment. Crocodiles, early primates, and a myriad of browsing forms indicate a relatively warm, lush environment. Sediments were deposited as areas surrounding the basin were uplifted. Streams drained into the basin but did not cut a channel through the basin boundaries. As a result, there was internal drainage where all the sediments from the surrounding highlands were deposited in the basin rather than being carried away by a major river.

There are no known fossil localities within the study area and the small outcrop area reduces the potential; but, considering the abundance of fossils found to the east, the occurrence of fossils is probable.

Vertebrate Fauna from the DeBeque Formation

Class: Osteichthyes
Order: Semionotiformes
Family: Lepisosteidae

Lepisosteus

Order: Siluriformes
Family: Ictaluridae

Genus indeterminate

Class: Reptilia
Order: Squamata
Family: Anguidae

Genus indeterminate

Order: Crocodilia
Family: Crocodilidae

Allognathosuchus sp.
Leidyosuchus riggsi
Certatosuchus burdoshi
Genus indeterminate

Class: Aves

Genus indeterminate

Class: Mammalia
Order: Multituberculata

Neoliotomus
Genus indeterminate

Order: Marsupialia
Family: Didelphidae

Mimoperadectes

Order: Deltatheridia
Family:

Didelphodis absarokae
D. altidens

Order: Insectivora
Family: Lepticidae

Palaeictops matthew
Prodiacodon ?

Family: Adapasoricidae

Sceropogus

Order: Primates
Family: Plesiadapidae

Plesidapis dubius

Family: Microsyopidae

Cynodontomys
New genus and species

Family: Adapidae

Pelycodus cf. *D. trigonodus*
Copelemur ?

Family: Paromomyidae

Phenacolemur

Order: Tillodontia
Family: Esthonychidae

Esthonyx bisulcutus
E. acutidens

Order: Rodentia
Family: Ischyromyidae

Microparamys
Paramys copei
P. excavatus
P. francesi
Reithroparamys debequensis
R. pattersoni
Thisbemys perditus
Lophiparamys debequensis
Pseudotomus coloradensis

Family: Sciuravide

Genus indeterminate

Order: Carnivora
Family: Miacidae

Didymictis protenus
cf. *Miacis exigus*
Vulpavus
Viveravus

Order: Creodonta
Family: Oxyaenidae

Oxyaena

Order: Condylarthra
Family: Phenacodontidae

Phenacodus primaevus
P. vortmani
P. brachypternus
Ectocion osbornianum
E. parvus ?
Prosthecion major

Family: Hyopsodontidae

Apheliseus
Haplomylus spierianus
Hyopsodus walcottianus
Hyopsodus loomisi
H. cf. *miticulus*
Hyopsodus sp. indeterminate
Aletodon gunnelli

Family: Mesonychidae

Pachaena ossifraga

Family: Arctocyonidae

Lambertocyon ischyrus

Family: Meniscotheriidae

Meniscotherium chamense
M. tapiacitis

Order: Pantodonta
Family: Barylambdidae

Barylamba faberi
Leptolamba schmidti
Haplolambda quinni

Family: Coryphodontidae

Coryphodon

Family: Titanoididae

Titanoides primaevus (Sparactolambda looki)

Order: Dinocerata
Family: Prodinocerotidae

Bathyopsoides harrisorum
Probathyopsis newbilli

Order: Taeniodontia
Family: Stylinodontidae

Lampadophorus expectatus
Ectoganus

Order: Perrisodactyla
Family: Equidae

Hyracotherium angustidens
H. vasaccience
H. crapedotum
New genus and species

Family: Isectolophidae

Homogalax protapirinus

Family: Helaletidae

Hetodon posticus
H. calciculus

Family: Paleotheriidae

Lambdotherium

Family: Brontotheriidae

Genus indeterminate

Order: Artiodactyla
Family: Diacodectidae

Wasatchia
Burophorus

(From Gazin 1953, 1965, 1968; Gingerich 1976, 1977, 1978; Kitts 1956; Novacek 1977; Patterson 1934, 1937, 1939, 1949; Patterson and Simons 1958; Patterson and West 1973; Radinsky 1963; Schmidt 1938, 1945; Simons 1960; Sloan et al. 1980; Van Houten 1945; Van Valen 1966; West 1976; Wood 1962; and ongoing research by the P.I. of this report).

Green River Formation

There are two members of the Green River Formation exposed in the study area. The lower unit is the Douglas Creek Member, a grey-green shale having beds of limestone, brown sandstone, and some siltstone. The upper unit is the Parachute Creek Member, a grey oil-shale with some marl beds. Contact with the underlying DeBeque Formation is conformable. The sediments are of Eocene age (47 ma to 43 ma).

The Green River Formation represents deposits of a relatively shallow saline inland lake which covered large portions of the Piceance Creek, Uintah, and Green River Basins. Fed by rivers which drained the surrounding highlands, the lake's depositional environment was somewhat similar to that of the present-day Great Salt Lake. Fossil vertebrates and various plant remains found indicate a warm subtropical climate.

The Green River Formation outcrops only in the far regions of the northern extension of the Mount Garfield Planning Unit. Highly vegetated or steep exposures occur at the top of the Book Cliffs.

Fossils are found well-preserved in the plate-like lake deposits of the Green River. The formation has yielded fish, turtle, alligator, and bat skeletons as well as bird tracks and impressions of feathers, leaves, larvae, and many flying insects. One yearling crocodile was found in the Douglas Creek Member only a few miles northwest of the study area (Langston and Hugh 1978).

Outcrops tend to weather as platy shales and coarse sandstone and limestone blocks. Fifty acres of highly vegetated and steep exposures were surveyed for the current study (see Appendix A). No fossils were found.

A potential for vertebrate fossils in the Green River Formation exists on the basis of the previously mentioned fossils. Due to the weathering of the outcrops, however, the potential for discovering fossil resources is low.

Vertebrate Fauna for the Green River Formation (from near the study area only)

Class: Reptilia
Order: Crocodilia
Genus unnamed

(From Langston and Rose 1978.)

Quaternary Period

Pleistocene and recent (Quaternary/Holocene) deposits within the project area consist of silts, sands, and gravel sediments. Often, these are terrace- and river-bottom forming, but also occur as talus, lake, and floodplain deposits. Beds of these deposits range locally from inches to one hundred feet in thickness and frequently occur on mesa tops and along canyon sides and bottoms. Contact with underlying formations or beds is usually unconformable. Pleistocene deposits are known in nearby areas (outside the study area) to contain mammoth teeth (Cook 1930, 1931; Young and Young 1977); these are 3 ma to recent in age. No fossils are known from the survey area.

Quaternary deposits occur in both planning units of the study area, and are most commonly exposed in drainage bottoms and on talus slopes. Beds of these gravels, silts, and sands tend to develop soils and are covered with vegetation.

Five acres of exposures were surveyed in the area of Granite Creek (Glade Park Planning Unit). No fossils were observed (see Appendix A).

Because vertebrate fossils have been found in Quaternary deposits elsewhere, it is likely that they occur in the study area as well. The potential for finding such is considered to be good.

SUMMARY

During the course of the Class I and Class II surveys of the study area, data was collected on the vertebrate fossil resources of each formation. Both known localities and those discovered during the current study (Appendices A and B) have been considered in evaluating the potential for discovering scientifically valuable vertebrate fossils within each formation. Accordingly, the thirteen formations which occur in the area have been ranked and placed into four groups (Table 2). Within the discussions of each of the four groups, management recommendations are given and comments on individual formations are made. (For outcrops of each group refer to Figure 2, the geologic map of the study area.)

Group I Formations

Group I formations are defined as those units which have a proven potential for fossil vertebrate resources in the study area. Three formations belong in this group: the Morrison Formation, the Mancos Shale, and the Burro Canyon Formation.

Because of the proven potential of these formations, certain management recommendations can be made.

a) Prior to any construction or excavation activities which will entail disturbance of these units, a field survey of the area to be adversely affected should be made. There should be sufficient time allowed for the survey to be completed, during suitable weather, and for any mitigation recommendations to be acted upon.

b) The field survey should be made by a qualified vertebrate paleontologist, an individual trained to recognize areas of likely occurrence and able to judge the significance

Table 2.

Relative Potential, by Formation, for Fossil Vertebrates in the Study Area

I.	1)	Morrison	most potential
	2)	Mancos	
	3)	Burro Canyon	
II.	4)	Chinle	
	5)	Mount Garfield	
	6)	Pleistocene deposits	
	7)	DeBeque	
	8)	Green River	
III.	9)	Kayenta	
	10)	Dakota	
	11)	Wingate	
	12)	Cutler	
IV.	13)	Summerville	
	14)	Hunter Canyon	
	15)	Sego	
	16)	Entrada	least potential

of any finds.

c) In the event of the location of fossil vertebrate material, the geographic and geologic occurrence should be noted, and a mitigation plan for the material should be developed.

Depending upon the nature of the material, the method of mitigation may vary. It can be as simple as surface salvage and involve merely recording the pertinent information and removing the specimen. Excavation may be called for, in which case the proper methods must be followed to protect the often fragile fossils. Where concentrations of fossils are located, quarrying of the fossiliferous matrix may be required. In very rare cases, the material may be so valuable that it warrants protection in place until a complete program of recording, excavation and/or preservation can be executed.

Based on the known occurrences within the study area, the three Group I formations can be ranked in order of importance.

1) The Morrison Formation has not only yielded many fossils, but also specimens which are among the best preserved in the world. The area is one of very few having well-preserved mammal fossils. In addition, the formation has a large areal extent, outcropping in many places adjacent to the growing urban area of Grand Junction.

2) The Mancos Shale is ranked second. Fossil vertebrates are much more rare in this formation but, because of its large areal extent and its proximity to Grand Junction, it will undoubtedly be affected by increasing population pressures.

3) The Burro Canyon Formation covers much less area. Because of its tendency to form vertical slopes, it is less prone to disturbance by development.

Group II Formations

This group is defined as those formations which have produced fossil vertebrates not in the study area but in the general area. Included are the Chinle, Mount Garfield, DeBeque, and Green River Formations, and miscellaneous Pleistocene deposits. These units probably manifest fossil vertebrate localities, but because of the limited field work conducted in the study area, such localities have not been identified.

The management recommendations for this group are:

a) For minor surface disturbances, such as fencing for livestock, a survey is not imperative.

b) Prior to major disturbance resulting from the construction of roads, well pads, pipelines, etc. a survey should be conducted as described for Group I formations. All recommendations listed under Group I apply to Group II formations in cases of major disturbance.

Ranking of the Group II formations is as follows:

4) Chinle Formation. Based on the locality near Bedrock, Colorado, it is felt that fossils are likely to occur in the formation within the study area. If so, they could be locally abundant and paleontologically valuable.

5) Mount Garfield Formation. There are several references to dinosaur tracks in coal mines in the general area. This is, however, a special case in that it is only by disturbance that the materials can be found. It is suggested that where federal lands are involved, if trackways or fossils are discovered during mining operations, the material should be made available to a paleontologist. Preservation of tracks by casting can be accomplished with minimum disruption to mining operations.

6) Pleistocene deposits. Rumors of Quaternary fossils within the study area have circulated but we were unable to locate any such specimens. Occurrence tends to be as isolated specimens. Because of the location of the majority of Pleistocene deposits, they are likely to be affected by population growth, and the potential for encountering material increases.

7) DeBeque Formation. This formation is abundantly fossiliferous directly east of the study area. In the study area proper, however, its relatively small areal extent limits its potential.

8) Green River Formation. Occasional specimens of excellent quality have been recovered from the Douglas Arch area. The occasional nature of specimens and the limited extent of the formation in the study area lessen its potential.

Group III Formations

This group includes those units which have produced either very occasional specimens or fossil vertebrates at a great distance from the study area. Formations included are the Cutler, Wingate, Kayenta, and Dakota.

Fossils are unlikely in these formations and, as such, even activities involving major disturbance will probably not adversely affect any resources. It is recommended that if major projects involving either Group I or II formations along with a Group III unit(s) are planned, then the Group III formation(s) should be surveyed. Only in cases where moderate or large areas are to be affected, is it recommended that a survey be conducted on a Group III formation solely.

The relative importance of the Group III units is:

9) Kayenta Formation. Based on the nature of the sediments

and outcrops, and the known abundance of fossils in the Kayenta, it is ranked at the top of the Group III formations.

10) Dakota Formation. Less accessible than the Kayenta, the Dakota has produced only occasional vertebrate fossils.

11) Wingate Sandstone. A difficult formation to survey because of its vertical outcrops, the Wingate has produced a record of footprints from near Bedrock, but its lack of horizontal exposures implies limited potential.

12) Cutler Formation. Elsewhere, the most fossiliferous Group III formation, the Cutler has very limited outcrops in the study area. Its possible close proximity to the source area may have resulted in sediments too course-grained to preserve fossils.

Group IV Formations

These formations are mainly characterized by a lack of information. Only the Summerville is reported to contain traces of vertebrate fauna -- these are in the form of footprints. Other units included in this group are the Sego Sandstone, the Hunter Canyon Formation, and the Entrada Sandstone.

Surveys are recommended for these formations only if Group I or II units are involved in the same project.

The ranking is as follows:

13) Summerville Formation. This is the only Group IV formation for which possible fossil remains are reported.

14) Hunter Canyon Formation. Nothing has been found in this formation, but the lithology is likely to contain fossils.

15) Sego Sandstone. The lithology of this formation has some potential for preserving fossils, but outcrops are not well-exposed.

16) Entrada Sandstone. No fossils are known from this unit. The eolian nature of the sediments makes preservation of fossils unlikely.

The above ranking has been provided to aid in the proper management of the study area's valuable paleontological resources. The Grand Junction vicinity has produced many fossils of scientific interest in the past and, with the advent of future population growth and the increased exploitation of local mineral deposits, it is hoped that these scientifically significant areas will be protected for the use of future researchers. This locale is known throughout the world for the discovery of both large dinosaurs and early mammals; undoubtedly, future paleontological finds will be made which will once again bring national and world-wide attention to the area.

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Johnson, Jim
Associate Professor of Geology at Mesa College, Grand Junction.

Lindsey, Don
Curator of Paleontology at the Denver Museum of Natural History, Denver.

Look, Alfred
Well-known local amateur paleontologist and author, Grand Junction.

Young, Robert W.
Geologist with Hunt Oil, Grand Junction.

* Asterisk indicates report directly concerned with study area.

GLOSSARY

(Modified from Van Couvering and Robinson 1980)

Amphibian	- That group of quadripedals which reproduce via an egg without an amniotic membrane; the young, after hatching, exist as a larval stage before metamorphosing to an adult.
Arch	- Structurally a linear uplift that is longer than wide. Serves to separate areas geographically and structurally. Douglas Arch.
Basin	- A structural bowl formed by either uplift on several sides of an area, or by subsidence of an area. Basin when initially formed tends to accumulate sediments. Piceance Basin.
Bed (bedding, bedded)	- A sedimentary layer, may be very thick (30 m or more, or very thin (less than 1 mm). A unit of sediment that has a similar history of deposition.
Bipedal	- Walking on two feet.
Cenozoic Era	- The major time unit comprising the last 65 Million Years of the Earth's time. It has two Periods, Tertiary and Quaternary (q.v.)
Conglomerate	- A rock layer made up predominantly of large (2mm diameter or greater) particles.
Continental	- Referring to those environments which occur on a continent as opposed to marine. Examples are streams, lakes, and sand dunes.
Cretaceous	- The final (youngest) period of the Mesozoic Era. The Cretaceous Period spans the time from 140 ma to 65 ma. It is generally characterized as a time when a shallow sea covered much of central North America.
Crocodilia	- A group of ruling reptiles which includes the modern-day crocodile, alligator, and gavial.

Crossbedded - When beds occur at various orientations relative to each other. Indicative of a changing direction of the mode of deposition, i.e., changing water currents in a stream, changing wind direction.

Dinosaur - A term referring to two of the groups of ruling reptiles, the ornithischia and saurischia. These two orders originated during the Triassic and were the dominant vertebrate type in the Jurassic and Cretaceous Periods. They became extinct, except for the birds, at the end of the Cretaceous.

Eocene - The second epoch of the Tertiary, spanning the time from 53.5 ma to 37 ma. A time when continental deposition occurred in many basins in the Rocky Mountain Region.

Eolian - Pertaining to wind; i.e., eolian sediments.

Epoch - The temporal subunit of a Period (q.v.). It is defined by its contained fossils. The rocks deposited during an Epoch represent a Series.

Era - One of the major units of geologic time. It is based on the fossils found in rocks of that age and has subordinate units called Periods. The rocks deposited in the time represented by an Era are said to represent an Erathem.

Exposure - A bare surface of outcrop (q.v.), usually denuded of all soil and vegetation.

Fauna - Referring to the group of animals that occurs in an environment. A fossil fauna is that group of animals for which identifiable fossilized remains have been recovered from a particular locality, formation, or time span.

Flora - Those plants that occur in a particular environment. A fossil flora is made up of those plants which have been identified from fossilized material in a particular locality, formation, or time span.

Fluvial	- Pertaining to river or stream environment; i.e., fluvial sediments
Formation	- A mapping term denoting a sedimentary rock unit that can be traced for a considerable distance. It usually has a distinctive lithology (q.v.) and is readily distinguishable from the units above and below it. It is not related to time units and the boundaries of a formation may cross time boundaries.
Group	- A sequence of two or more formations representing a major sedimentary cycle. The upper and lower boundaries of a group may represent major breaks in the rock record.
Holotype	- Also called Type Specimen. The specimen upon which a species is defined. The type specimen in paleontology is the specimen whose characters are described and distinguished from the characters of other species.
Jurassic	- The middle of the three Periods of the Mesozoic Era. It is the time which saw the development of the very large dinosaurs (for example, Diplodocus) and is widely represented in Colorado by the rocks of the Morrison Formation.
Lacustrine	- Referring to lake deposition.
Lithology	- Of or pertaining to the particles constituting a rock or rocks. Typical lithologies are shale, sandstone, limestone, etc.
Littoral	- Of or pertaining to the beach (Lat. Littora,ae, beach).
Ma (Mega annum)	- One million (1,000,000) years, equivalent to mybp,million years before present, but less cumbersome.
Mammal	- Referring to that group of animals which give birth to the young alive, suckle the young, have hair and are warm-blooded. Man, dogs, horses, bison, and bats are a few common types.
Massive	- A rock unit with no visible or obvious bedding.

Member	- A rock unit term, a subdivision of a Formation and usually mappable on a local basis.
Mesozoic	- The second of the three eras with abundant fossil remains, bounded by the Paleozoic Era below and the Cenozoic Era above. It lasted from approximately 230 to 65 Million years ago. It has three Periods (in ascending order): Triassic, Jurassic and Cretaceous (q.v.).
Mudball Cong.	- A conglomerate in which erosion of softer sediments has produced particles of mud as the large particles. These sediments very often contain fossils.
Mudstone	- A rock unit made up of mud-sized particles; differs from a shale by the lack of thin bedding or platy character.
Order	- A level of taxonomy which groups those organisms which share a common ancestry and are easily separable from other orders based on major morphologic characters. Primates, Carnivores, and Chiropterans (bats) are three examples of orders.
Ornithischia	- An order of ruling reptile with a bird-like pelvis. Includes large bipedal herbivores (ornithopods) and several lineages of quadripedal herbivores (stegosaurs, ceratopsians).
Orogeny	- A major period of mountain building involving some thousands of square kilometers. Orogeny often follows deposition in a trough (q.v.) or the two are coincident.
Outcrop	- The interface of rock formation and the surface of the land.
Paleocene	- The first (earliest) epoch of the Tertiary, spanning the time from 65 ma to 53.5 ma. This is the time when basins began to develop in the Rocky Mountain Region and mammals became the dominant vertebrate type.
Paleozoic	- Of or pertaining to the oldest of the three Eras of abundant fossil life. It comprises the following Periods (in ascending order): Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian, and Permian. It commenced some 600 ma and ended approximately 230 ma.

Paludal - Pertaining to a swamp environment.

Pelecypod - Referring to a group of animals having two, or less commonly one, shells. Clams, oysters, and scallops are common types.

Pennsylvanian - The sixth of the seven Paleozoic Periods. It lasted from 325 to 280 ma.

Period - A subunit of an era and, like the Era, is defined by the fossils contained in rocks of that time unit. Several Periods make up an Era. A Period also has subunits called Epochs. The rocks deposited in a given period represent a System.

Permian - The seventh and last of the Paleozoic Periods. It typically has red sandy rock units and is known for its important fossil reptile faunas. A significant extinction of both land and marine animals and plants at the end of the Permian marks the change from the Paleozoic to the Mesozoic Eras. It lasted from approximately 280 to 230 ma.

Quadripedal - Walking on four feet.

Quaternary - The youngest Period of the Cenozoic Era. It dates from approximately 1.8 (or 1.2) ma to the present. It has two Epochs, the Pleistocene (up to 12,000 years before the present) and the Recent (12,000 YBP to present).

Reptile - That group of animals which reproduces via an amniote egg, the young hatching as more or less miniature adults.

Sandstone - A rock composed of grains of sand-size (2 millimeter to 1/16 millimeter) cemented or uncemented by another substance. Sandstone is usually composed of quartz but may also have other minerals and rock fragments as part of its composition.

Saurischia - An order of ruling reptiles with a lizard-like pelvis. Includes the largest dinosaurs (sauropods) and the large carnivorous types (carnosaurs).

Sauropod - Referring to a subgroup of the Order Saurischia. This subgroup includes all of the very large quadripedal dinosaurs; i.e., *Brachiosaurus* and *Apatosaurus*. These forms were plant eaters.

Shale - A sedimentary rock usually composed of clay minerals (silicate minerals less than 1/256 millimeter in diameter). Common clay minerals are Kaolinite, Illite, and Montmorillinite. Shales usually have a tendency to separate more or less parallel to the bedding surface. This tendency is called fissility.

Siltstone - A sedimentary rock similar to sandstone (q.v.) but composed of grains between 1/16th and 1/256th millimeter in size.

Species - A population of potentially interbreeding individuals, reproductively isolated from all other populations. In paleontology, species are generally recognized by a distinct morphology, although age and geography can be factors.

Taxon (p. taxa) - A unit of the scientific classification of animals and plants. Depending on usage, it can be as detailed as a species or as general as a class. When used, all taxa referred to should be of equal rank.

Tertiary - The older of the two Periods of the Cenozoic Era. It dates from approximately 65 to approximately 1.8 (or 1.2) ma. It has five Epochs: in ascending order, Paleocene, Eocene, Oligocene, Miocene and Pliocene.

Theropod - Referring to a subgroup of the Order Saurischia that includes the large meat-eating dinosaurs; i.e., *Allosaurus*, and *Ceratosaurus*.

Triassic - Of or pertaining to the first of the three Periods of the Mesozoic Era. It is important as beginning the dominance of Reptiles on the land and for the evolution of the first mammals. It lasted from 230 to 195 ma.

Trough - In geological terms, this refers to a major downwarp or depression in the Earth's crust in which sediments accumulate, often rapidly. Troughs usually occupy some thousands of square kilometers.

Type Locality - The locality from which the type specimen was collected. Information includes type of sediments, name of unit, geographic location and age, if known.

Type Specimen - Also called the Holotype. The specimen upon which a species is defined. The type specimen in paleontology is the specimen whose characters are described and distinguished from the characters of other species.

Vertebrate - Animals with backbones, either made of bone or cartilage.

Appendix A

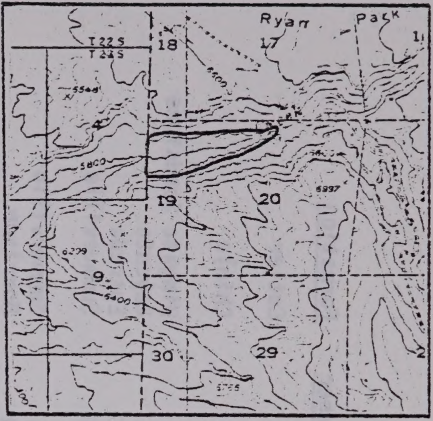
Areas Surveyed

Table of Areas Surveyed

Survey Area	Legals		P.M.	Location	Sec.	Acreage	Landowner	Formation
Cut-1	T14S,	R104W	6th	N½	19	65	BLM	Cutler
				N½	20			
Chi-1	12S	103W	6th	E½ SW¼	35	40	BLM	Chinle
				W½SW¼SE¼				
Win-1	1S	1W	Ute	N½NW¼	31	40	NPS	Wingate Sandstone
Kay-1	12S	101W	6th	NE¼NW¼SE¼	6	15	NPS	Kayenta
Ent-1	12S	101W	6th	W½SW¼	5	30	NPS	Entrada
Sum-1	12S	100W	6th	NW¼NW¼	30	45	BLM	Summerville
				SW¼SW¼	19			
Sum-2	11S	101W	6th	SE¼NW¼	30	5	NPS	Summerville
Mor-1	12S	100W	6th	S½S½	19	80	BLM	Morrison
				N½N½	30			
Mor-2	11S	102W	6th	NE¼	27	65	BLM	Morrison
Mor-3	1N	3W	Ute	SE¼SE¼SW¼SE¼	13	5	BLM	Morrison
BCn-1	13S	99W	6th	SW¼SW¼SW¼	8	35	BLM	Burro Canyon
				W½NW¼NW¼	17			
				NE¼SE¼NE¼	18			
BCn-2	12S	100W	6th	S½S½	19	10	BLM	Burro Canyon
Dak-1	12S	100W	6th	S½S½	19	5	BLM	Dakota Sandstone
Man-1	1N	1E	Ute	E½NE¼SW¼	23	60	BLM	Mancos Shale
				C S½NW¼				
				NW¼SW¼				
Man-2	1N	1E	Ute	E½NW¼	33	80	BLM	Mancos Shale
				E½SW¼	28			
Man-3	1N	1E	Ute	C E½E½NW¼	8	15	BLM	Mancos Shale
Man-4	1N	1E	Ute	C E½NE¼	8	30	BLM	Mancos Shale
				SW¼NW¼NW¼	9			
Man-5	8S	102W	6th	SE¼SE¼SE¼	15	5	BLM	Mancos Shale
				E½NE¼NE¼	22			
Seg-1	8S	102W	6th	NW¼SW¼	12	5	BLM	Sego Sandstone
MGa-1	8S	102W	6th	NW¼SW¼	12	5	BLM	Mount Garfield
HCa-1	7S	101W	6th	C W½	20	25	BLM	Hunter Canyon
DBe-1	7S	101W	6th	C W½W½	10	30	BLM	DeBeque
GRi-1	7S	101W	6th	NW¼NW¼NW¼	10	50	BLM	Green River (Douglas Creek)
				SW¼SW¼	3			
Qua-1	14S	104W	6th	N½	19	5	BLM	Quaternary Alluvium
				N½	20			

SURVEY AREA: Cutler - 1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 14 S Range 104 W ; 6th P.M.

¼ of ¼ of ¼ of N½ ¼, Sec. 19 ;

¼ of ¼ of ¼ of N½ ¼, Sec. 20 .

U.S.G.S. Quad. "Coates Creek, Utah-Colorado"

1954 , 15 min.

UTM 12 ; 670000 mE; 4300000 mN

Landowner Bureau of Land Management

ACCESS: From Grand Jct., drive southwest on Monument Canyon road 7 miles to Glade Park Store turnoff. Turn south, travel 16 miles to fork. Head southwest (along Coates Cr.), travelling 10 miles. Heading north, then west, drive 7.5 miles to fork, turn south, travel 8 miles, turn east, travel 2.5 miles to Granite Canyon rim. Drop into canyon, walk east up drainage 2 miles to Colo. border. Study area is east of here.

DESCRIPTION:

Erathem Paleozoic System Pennyslvanian-Permian

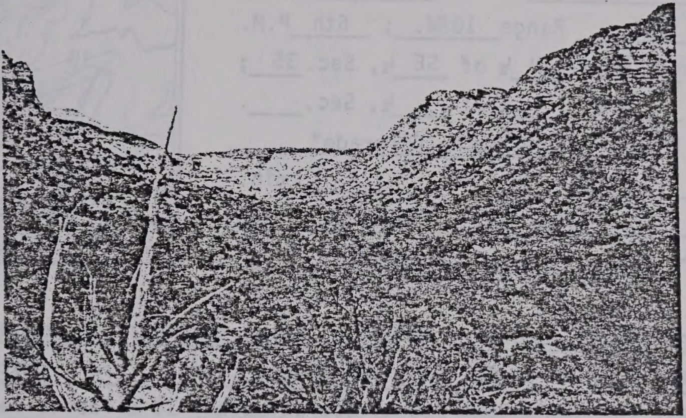
Formation Cutler Member

Unit Position within Unit

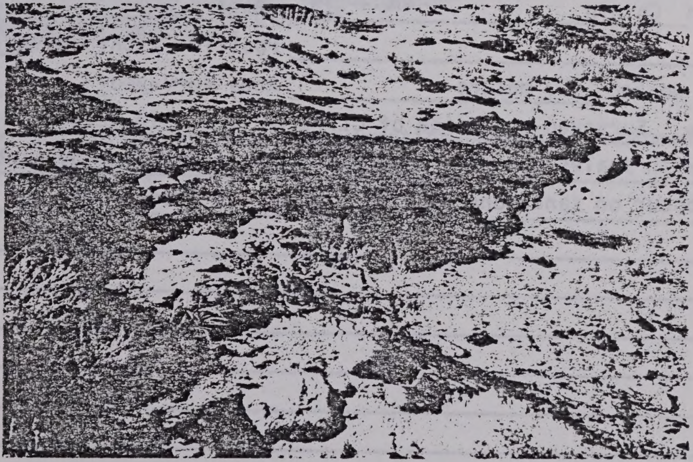
Sections worked 30 meters Area surveyed 65 acres

Narrative This area is extremely inaccessible, reached only by four-wheel drive. The best exposures of this pinkish-grey sandy conglomerate are just outside the study area in Utah. The formation is made of reworked underlying Precambrian granites and schists. No fossils were observed. Only one unvegetated outcrop was noted. Area is highly weathered and vegetated.

RESOURCE POTENTIAL Probability of finding vertebrate fossils is low due to coarse-grained sediments.



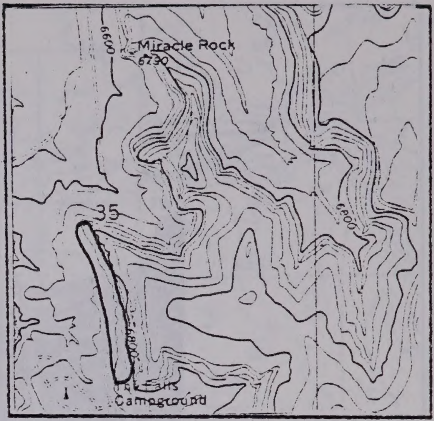
Looking east at Granite Creek from the Utah/Colorado border. Quaternary alluvium lines the creek bed, above which are (in order) the Cutler, Chinle, and Wingate Formations.



Looking northwest at best exposure of Cutler Formation in Granite Creek.

SURVEY AREA: Chinle-1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 12S. Range 103W. ; 6th P.M.

E½ SW¼ and W½ of SW ¼ of SE ¼, Sec. 35 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Payne Wash, Colorado"

1969 , 7.5 min.

UTM 12 ; 684600 mE; 4315000 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, Colorado, drive southwest on Monument Canyon Road approximately 7 miles to Glade Park Store turnoff. Turn south and follow road west (past the Glade Park Store) approximately 15 miles to fork in road. Turn south and follow road approximately 2 miles to the Falls Campground turnoff. Exposures are on the east side of the road.

DESCRIPTION:

Erathem Mesozoic System Triassic

Formation Chinle Member

Unit Position within Unit

Sections worked 50 meters Area surveyed 40 acres

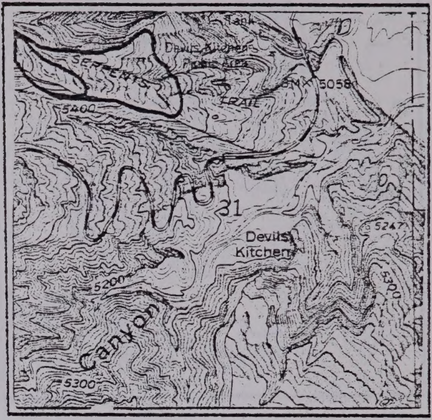
Narrative Surveyed west side of cliff -- red, thin-bedded sandstones interbedded with shales and some conglomerates. Extensive invertebrate tracks and trails occur on sandstone bedding planes. No fossil bone was spotted.

RESOURCE POTENTIAL Some possibility of finding bone exists due to fossiliferous deposits outside study area.

Looking northeast at Chinle Formation prospected, capped by Wingate sandstone.

SURVEY AREA: Wingate-1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 1S. Range 1W. ; Ute P.M.

___ ¼ of ___ ¼ of N½ ¼ of NW ¼, Sec. 31 ;

___ ¼ of ___ ¼ of ___ ¼ of ___ ¼, Sec. ___.

U.S.G.S. Quad. "Colorado National Monument, Colorado," 1962 revised 1973, 7.5 min.

UTM 12 ; 704500 mE; 4322900 mN

Landowner National Park Service

ACCESS: From Grand Junction, drive approximately 4.4 miles southwest on Colorado National Monument Road to East Entrance of the Colorado National Monument. From here drive approximately 2.7 miles to head of Serpents Trail. Exposures are to the southeast.

DESCRIPTION:

Erathem Mesozoic System Triassic

Formation Wingate Sandstone Member

Unit Position within Unit

Sections worked 50 meters Area surveyed 40 acres

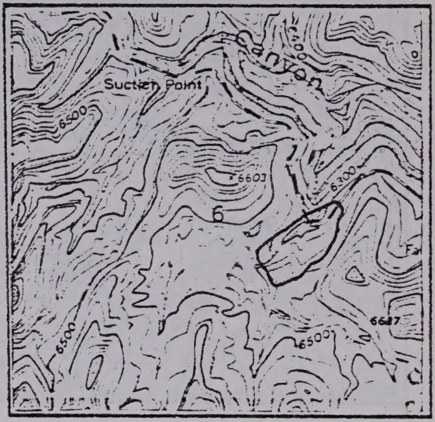
Narrative This formation has good outcrops on CNM land, indicative of its character in the area. Outcrops as massive to thin-bedded sandstone, white to red. No fossils observed.

RESOURCE POTENTIAL Low potential for vertebrate fossils. Only tracks have been found (outside the study area).

Looking southeast at Wingate Sandstone exposures at head of the Serpents Trail.

SURVEY AREA: Kayenta-1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 12S. Range 101W. ; 6th P.M.

¼ of NE ¼ of NW ¼ of SE ¼, Sec. 6 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Colorado National Monument, Colorado," 1962, revised 1973, 7.5 min.

UTM 12 ; 697700 mE; 4235000 mN

Landowner National Park Service

ACCESS: From Grand Junction, drive approximately 4.4 miles southwest on Colorado National Monument Road to East Entrance of the Colorado National Monument. From here drive approximately 10.2 miles (past Fallen Rock Overview). Exposures are on the south side of road.

DESCRIPTION:

Erathem Mesozoic

System Triassic

Formation Kayenta

Member

Unit

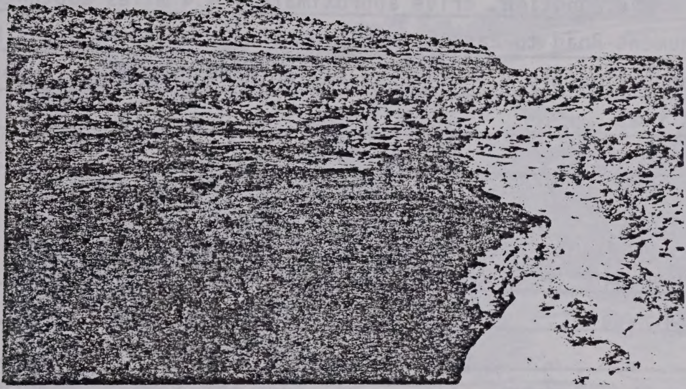
Position within Unit

Sections worked 30 meters

Area surveyed 15 acres

Narrative Various lithologies represented. Thin-bedded white sandstone, red sandstone; and of note mudball conglomerate seen above Ute Canyon and in tunnel under road west of Ute Canyon Overlook. Also checked ceiling of tunnel for tracks, none seen.

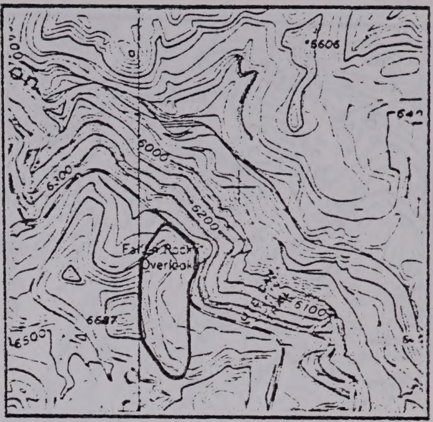
RESOURCE POTENTIAL Some possibility of vertebrate fossil occurrence.



Looking southeast at Kayenta Formation in Ute Canyon. Tunnel (center) checked for fossil tracks. Entrada occurs above tree-covered bench.

SURVEY AREA: Entrada-1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 12S. Range 101W. ; 6th P.M.

¼ of ¼ of W½ of SW ¼, Sec. 5 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Colorado National Monument, Colorado," 1962, photorev. 1973, 7.5 min.

UTM 12 ; 698300 mE; 4232000 mN

Landowner National Park Service

ACCESS: From Grand Junction, drive approximately 4.4 miles southwest on Colorado National Monument Road to East Entrance of the Colorado National Monument. From here drive approximately 9.5 miles to Fallen Rock Overview. Exposures are on west side of road.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Entrada Member

Unit Position within Unit

Sections worked 30 meters Area surveyed 30 acres

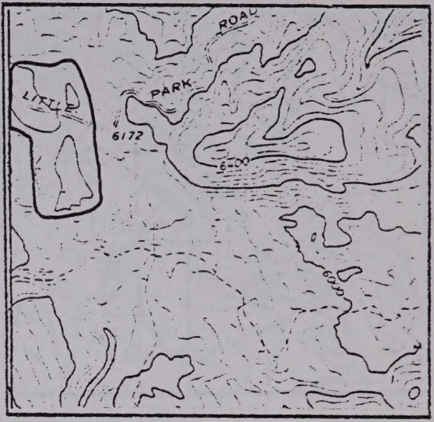
Narrative Well sorted sand, crossbedded, mostly reddish. No fossils seen.

RESOURCE POTENTIAL Extremely low. No fossils have ever been found in this formation.

Looking west at Entrada Formation exposure surveyed near Ute Canyon, Colorado National Monument.

SURVEY AREA: Summerville-1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 12S. Range 100W. ; 6th P.M.

¼ of ¼ of NW ¼ of NW ¼, Sec. 30 ;

¼ of ¼ of SW ¼ of SW ¼, Sec. 19 .

U.S.G.S. Quad. "Island Mesa, Colorado," 1969

, 7.5 min.

UTM 12 ; 706000 mE; 4318400 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, drive 1 mile south on Colorado Highway 50 to traffic intersection in bend of road. Turn south, follow road around cemetery approximately .6 mile. Turn north and drive approximately .7 mile (across the Gunnison River) to Little Park Road. Follow Little Park Road approximately 5.6 miles to road intersecting from the south. Survey area is flat land west of this spot.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Summerville Member

Unit Position within Unit

Sections worked 35 meters Area surveyed 45 acres

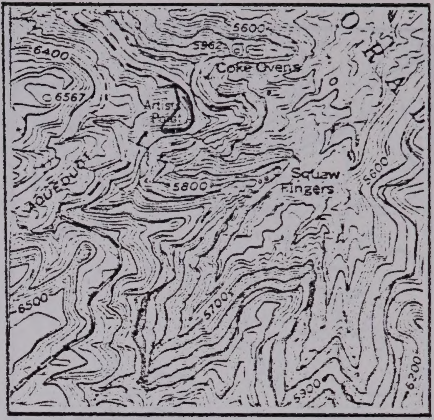
Narrative Weathered outcrop consisting of thin-bedded grey, red, purple, and green shales with interbedded tan sandstones. About 10 meters of basal Morrison also inspected here. No fossils spotted except possible shell fragments.

RESOURCE POTENTIAL Chances of findings vertebrate fossils are low.

Looking east at Summerville Formation outcrop (left and vegetated foreground) along Little Park Road. Little Park Morrison Formation locality (8050-6) is hill in background (center).

SURVEY AREA: Summerville-2

Locality Number:



LOCATION:

State Colorado County Mesa

Township 11S. Range 101W. ; 6th P.M.

¼ of ¼ of SE ¼ of NW ¼, Sec. 30 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Colorado National Monument, Colorado," 1962, Photorevised 1973, 7.5 min.

UTM 12 ; 696950 mE; 4327150 mN

Landowner National Park Service

ACCESS: From Grand Junction, drive approximately 4.4 miles southwest on Colorado National Monument Road to East Entrance of the Colorado National Monument. From here drive approximately 14.6 miles to Artist's Point. Exposures occur in road cut on west side of road.

DESCRIPTION:

Erathem Mesozoic System Jurassic

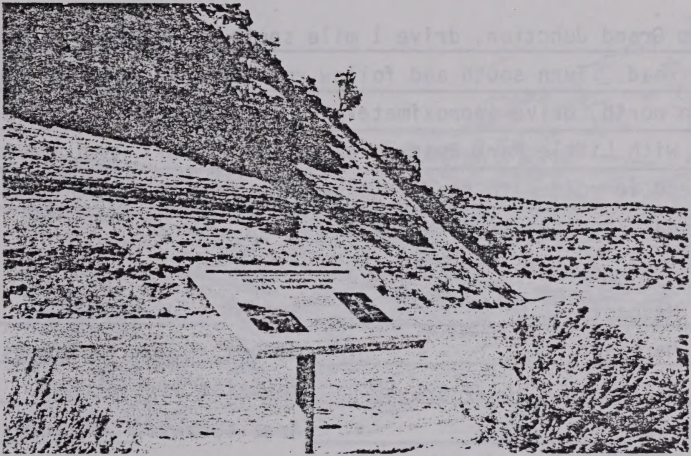
Formation Summerville Member

Unit Position within Unit

Sections worked 10 meters Area surveyed 5 acres

Narrative Thin red and green clay layers with thin sandstone layers. Fairly fresh road cut. No fossils observed. A measured section has been described from this area by Lohman (1965). Gastropods were found here by Callison (1977).

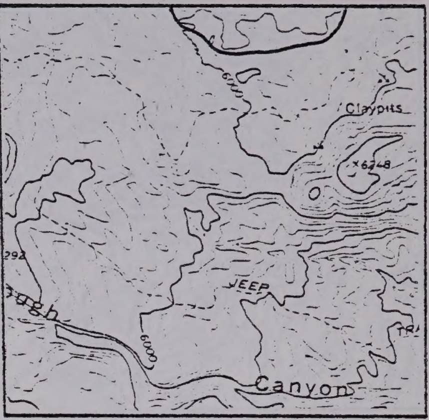
RESOURCE POTENTIAL A possibility of finding bone exists, but chances of finding vertebrate fossils are low.



Looking northwest at Summerville Formation road cut at Artist's Point, Colorado National Monument.

SURVEY AREA: Morrison-1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 12S. Range 100W. ; 6th P.M.

S½ of S½ Sec. 19 and N½ N½ , Sec. 30 ;

___¼ of ___¼ of ___¼ of ___½, Sec.___.

U.S.G.S. Quad. "Island Mesa, Colorado,"

1969 , 7.5' min.

UTM 12 ; 707000 mE; 4318000 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, drive 1 mile south on Colorado Highway 50 to intersection in bend of road. Turn south and follow road around cementery approximately .6 mile. Turn north, drive approximately .7 mile (across the Gunnison River) to intersection with Little Park Road. Follow Little Park Road approximately 5.6 miles to bend in road with road intersecting from the south. Walk approximately 400 meters east/southeast to exposures.

DESCRIPTION:

Erathem Mesozoic

System Jurassic

Formation Morrison

Member Salt Wash/Brushy Basin

Unit upper Salt Wash & lower Brushy B.

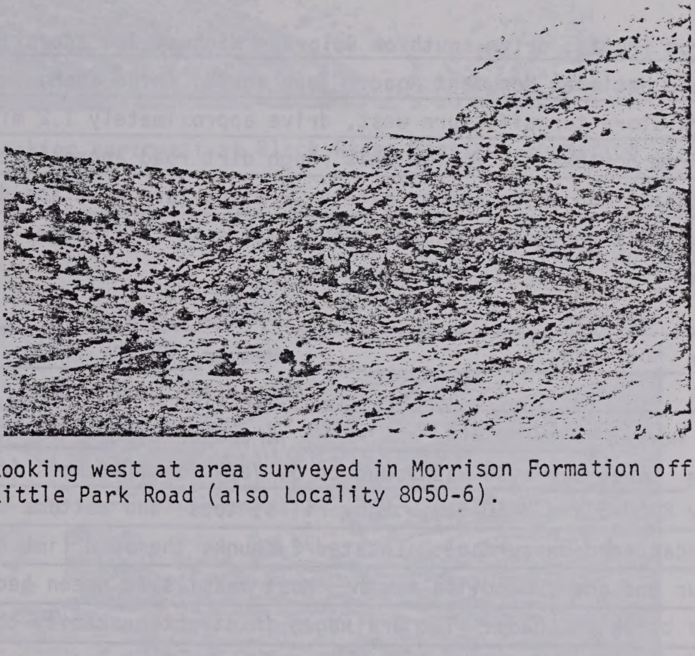
Position within Unit

Sections worked 50 meters

Area surveyed 80 acres

Narrative Brushy Basin Member consists of tan sandstones, red mudstones, and grey mudstones. Salt Wash Member consists of variegated red and grey to green mudstones with sandstone lenses. Small pieces of bone and petrified wood found at contact of members. Locality similar to Fruita Paleontological area stratigraphically.

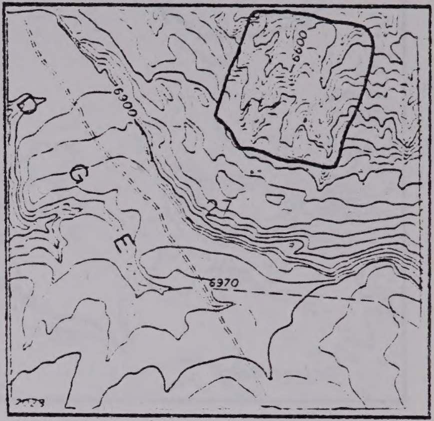
RESOURCE POTENTIAL Chances are very good for finding vertebrate fossils. (Of the formations within the study area, this formation has the greatest potential.)



Looking west at area surveyed in Morrison Formation off Little Park Road (also Locality 8050-6).

SURVEY AREA: Morrison-2

Locality Number:



LOCATION:

State Colorado County Mesa

Township 11S. Range 102W. ; 6th P.M.

___¼ of ___¼ of ___¼ of NE ¼, Sec. 27 ;

___¼ of ___¼ of ___¼ of ___¼, Sec.___.

U.S.G.S. Quad. "Battleship Rock, Colorado,"

1962 , 7.5 min.

UTM 12 ; 692500 mE; 4327000 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, drive south on Colorado Highway 340 approximately 2.4 miles to Colorado National Monument Road. Turn south, drive approximately 8.5 miles to Glade Park Store turnoff, turn west, drive approximately 1.2 miles to road intersecting from northwest. Follow this rough dirt road approximately 1.3 miles, turn northeast and drive approximately .1 mile, turn west and drive approximately 1.1 mile. Walk north approximately 500 meters to cliff edge. Locality is set of exposures below cliff.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Brushy Basin

Unit Position within Unit

Sections worked 50 meters Area surveyed 65 acres

Narrative Area surveyed was found to be very fossiliferous (designated locality 8050-5 and 8050-5a). Many rills, tops, and bottoms of hills had bone pieces scattered on surface. Located 2 chunks theropod limb bone, four carnosaur and one crocodilia tooth. Most fossils in green beds approximately 5 meters below red beds. Two drainages in direct proximity to each other were surveyed.

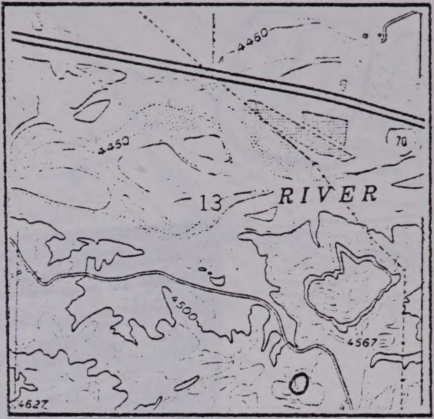
RESOURCE POTENTIAL Due to excellent exposures and abundance of bone fragments, the area holds great potential.

Looking northwest at Black Ridge Morrison Formation exposures.

Looking south at same drainage as above.

SURVEY AREA: Morrison-3

Locality Number:



LOCATION:

State Colorado County Mesa

Township 1N. Range 3W. ; Ute P.M.

SE ¼ of SE ¼ of SW ¼ of SE ¼, Sec. 13 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Mack, Colorado," 1962 revised 1973, 7.5 min.

UTM 12 ; 694500 mE; 4335700 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, travel south approximately 1.5 miles on Colorado Highway 340. Turn west onto intersecting road and drive approximately .6 mile. Turn southwest and drive approximately 1.2 miles. Walk west approximately 100 meters to hill surveyed.

DESCRIPTION:

Erathem Mesozoic

System Jurassic

Formation Morrison

Member Salt Wash

Unit upper

Position within Unit near contact w/Brushy Basin

Sections worked 10 meters

Area surveyed 5 acres

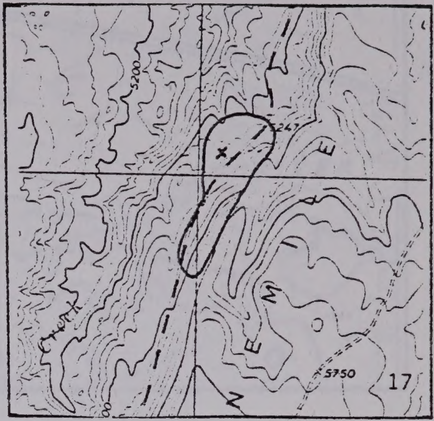
Narrative Hill is known for its specimens of the gastropod *Valvata scabrida*. Exposure is basal green with upper red mudstone and sandstone layers. Recent quarrying or digging activity noted on east side of hill. No fossils spotted at hill except for extremely weathered fragments.

RESOURCE POTENTIAL Area holds high potential for vertebrate fossils due to bone fragments present and proximity to the Fruita Paleontological Area.

Looking west at Morrison-3 survey area. Low hill (center) is shown in relation to 8050-4 Fruita Paleontological Area (left of center).

SURVEY AREA: Burro Canyon-1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 13S. Range 99W. ; 6th P.M.

SW¼ of SW¼ of SW¼ Sec. 8; W½ of NW¼ of NW¼ Sec. 17; NE¼ of SE¼ of NE¼ Sec. 18 .

U.S.G.S. Quad. "Whitewater, Colorado," 1969 , 7.5 min.

UTM 12 ; 717700 mE; 4311950 mN

Landowner Bureau of Land Management

ACCESS: From the intersection of Colorado Highways 50 and 141 near Whitewater, drive southwest approximately 5.0 miles to turnoff by large boulder on the west side of road. Fossil casts are in side of this boulder, facing the road. Boulder fell from near top of hill on east side of road.

DESCRIPTION:

Erathem Mesozoic System Cretaceous

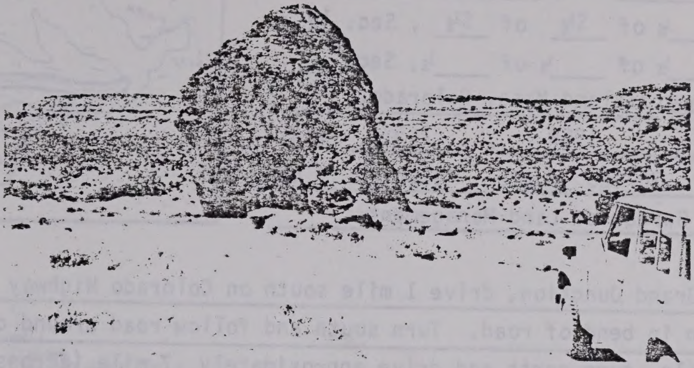
Formation Burro Canyon Member

Unit lower Position within Unit conglomerate between sandstone beds

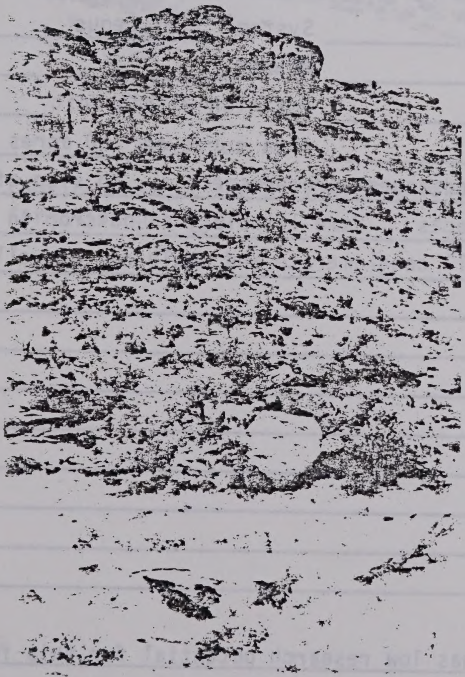
Sections worked 15 meters Area surveyed 35 acres

Narrative In boulder, there are at least six bone molds, one good theropod femur mold, one other long bone mold, petrified wood, and three bone-fragment molds. Boulder fell from cliffs across road. These cliffs were surveyed, but only fossil wood in the form of logs, pieces, and stumps was found.

RESOURCE POTENTIAL Due to presence of bone molds and fossil wood, potential for vertebrate fossils is quite high.



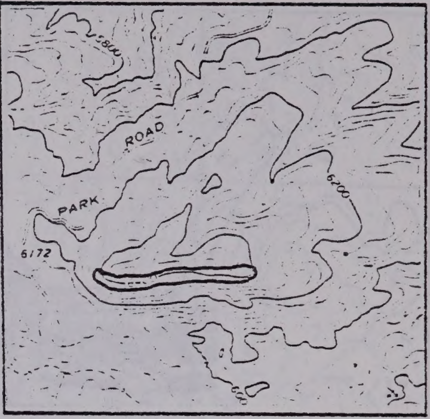
Looking northwest at boulder with fossil bone molds.



Looking southeast at cliff across road from fossiliferous boulder. Sandstone layers on top are Burro Canyon Formation, slope below is Morrison Formation.

SURVEY AREA: Burro Canyon-2

Locality Number: ____



LOCATION:

State Colorado County Mesa

Township 12S. Range 100W. ; 6th P.M.

___¼ of ___¼ of S½ of S½ , Sec. 19 ;

___¼ of ___¼ of ___¼ of ___¼, Sec.___.

U.S.G.S. Quad. "Island Mesa, Colorado,"

1969 , 7.5 min.

UTM 12 ; 707080 mE; 4318020 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, drive 1 mile south on Colorado Highway 50 to traffic intersection in bend of road. Turn south and follow road around cementery approximately .6 mile, turn north and drive approximately .7 mile (across the Gunnison River) to intersection with Little Park Road. Follow Little Park Road approximately 5.6 miles to bend in road with road intersecting from the south. Walk approximately 400 meters east to exposures.

DESCRIPTION:

Erathem Mesozoic System Cretaceous

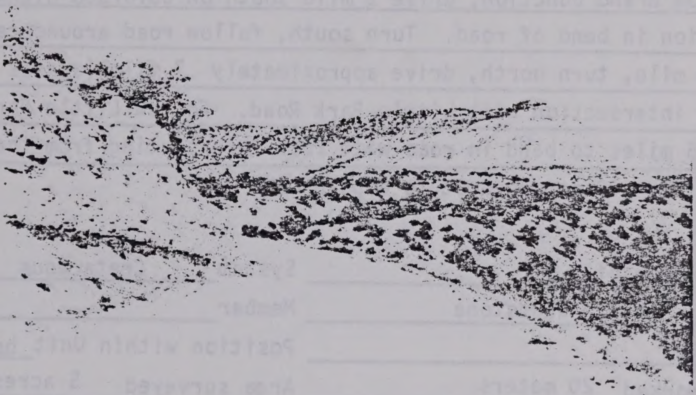
Formation Burro Canyon Member ____

Unit entire formation Position within Unit ____

Sections worked 15 meters Area surveyed 10 acres

Narrative Cliff-forming sandstones were prospected. No sign of bone or molds in conglomeratic boulder surfaces. Same lithology as outcrop in Unaweep Canyon (Burro Canyon-1) except mudball conglomerate and shale not as well developed.

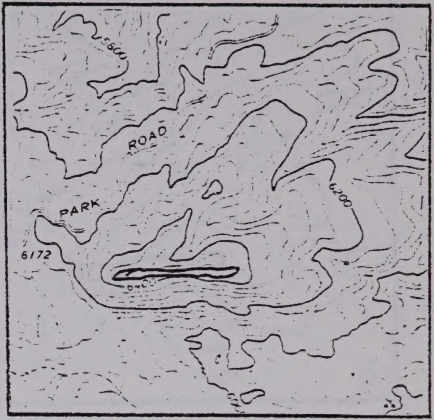
RESOURCE POTENTIAL The area has low research potential for this formation due to scarcity of mudball conglomerates.



Looking east at far hill with exposures of Burro Canyon Formation near top.

SURVEY AREA: Dakota-1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 12S. Range 100W. ; 6th P.M.

¼ of ¼ of S½ ¼ of S½ ¼, Sec. 19 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Island Mesa, Colorado," 1969, 7.5 min.

UTM 12 ; 707080 mE; 4318020 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, drive 1 mile south on Colorado Highway 50 to traffic intersection in bend of road. Turn south, follow road around cemetery approximately .6 mile, turn north, drive approximately .7 mile (across the Gunnison River) to intersection with Little Park Road. Follow Little Park Road approximately 5.6 miles to bend in road with road intersecting from the south. Walk approximately 400 meters east to exposures.

DESCRIPTION:

Erathem Mesozoic

System Cretaceous

Formation Dakota Sandstone

Member

Unit lower

Position within Unit bottom 20 meters

Sections worked 20 meters

Area surveyed 5 acres

Narrative Exposure consists of yellow-brown and brown sandstones with occasional conglomerates. No fossils observed.

RESOURCE POTENTIAL Possibility of finding vertebrate resources in this area of the formation are low.

Looking east at far hill with exposures of Burro Canyon Formation near top, topped by Dakota Sandstone.

40

SURVEY AREA: Mancos-1

Locality Number:

LOCATION:

State Colorado County Mesa

Township 1N. Range 1E. ; Ute P.M.

E½ NE¼ SW¼ and C of S½ NW¼ and NW¼ SW¼

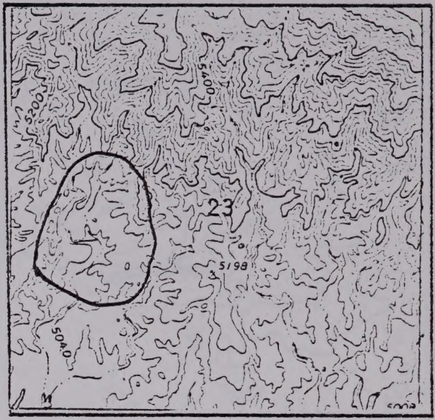
¼ of ¼ of ¼ of ¼, Sec. 23 .

U.S.G.S. Quad. "Round Mountain, Colorado,"

1962 , 7.5 min.

UTM 12 ; 720000 mE; 4335100 mN

Landowner Bureau of Land Management



ACCESS: From Grand Junction, drive north on 29 Road approximately 2.2 miles to intersecting road crossing I-70. Turn north, drive approximately .2 mile across I-70. Turn east onto intersecting road and drive approximately 2.5 miles to dirt road intersecting from north. Follow this road north along hilltops approximately 2.6 miles to survey area near the Book Cliffs.

DESCRIPTION:

Erathem Mesozoic

System Cretaceous

Formation Mancos Shale

Member

Unit middle to upper

Position within Unit grey mudstones

Sections worked 50 meters

Area surveyed 60 acres

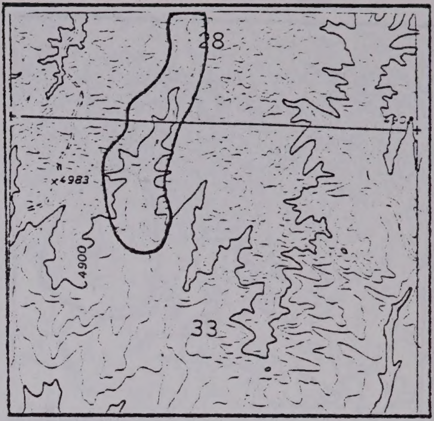
Narrative Upper section is composed of grey shale with orange-brown limestones. Baculites, pelecypods noted in section.

RESOURCE POTENTIAL Due to excellent exposures, the area holds high potential for finding vertebrate fossils.

Looking northwest at Mancos Shale exposures surveyed near Book Cliffs. Hills in center were prospected.

SURVEY AREA: Mancos-2

Locality Number:



LOCATION:

State Colorado County Mesa

Township 1N. Range 1E. ; Ute P.M.

¼ of ¼ of E½ of NW ¼, Sec. 33 ;

¼ of ¼ of E½ of SW ¼, Sec. 28 .

U.S.G.S. Quad. "Clifton, Colorado," 1962

, 7.5 min.

UTM 12 ; 717000 mE; 4333000 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, drive north on 29 Road approximately 2.2 miles to intersecting road crossing I-70. Turn north and drive approximately .2 mile across I-70. Turn east onto intersecting road and drive approximately 1.2 miles to dirt road intersecting from the north. Turn north and drive approximately .8 mile through drainage to survey area.

DESCRIPTION:

Erathem Mesozoic System Cretaceous

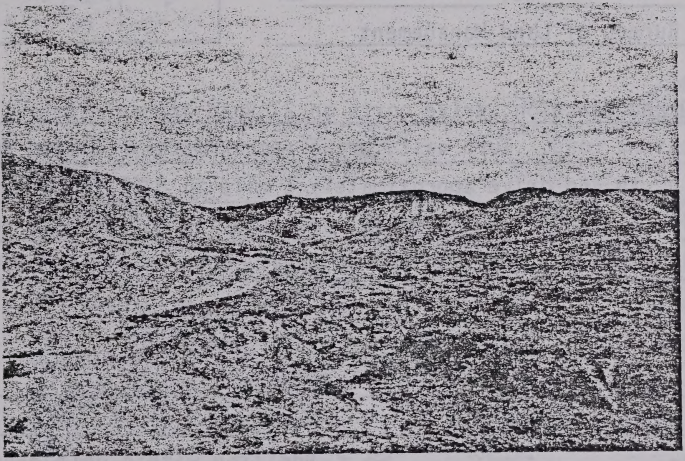
Formation Mancos Shale Member

Unit lower Position within Unit grey beds

Sections worked 50 meters Area surveyed 80 acres

Narrative Lower section is composed of mostly weathered brownish grey shales with thin sandstone plates scattered on outcrop. No fossils observed.

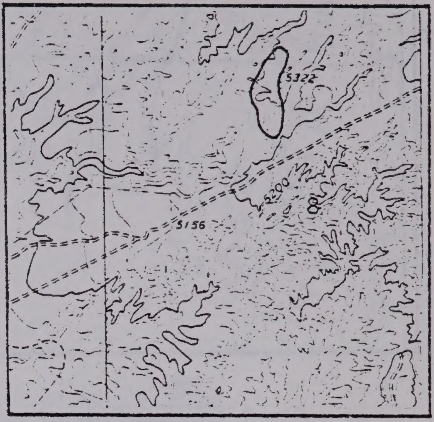
RESOURCE POTENTIAL Because of good exposures, the area holds potential for finding fossil vertebrates.



Looking north at Mancos Shale exposures survyed in drainage west of Lewis Wash.

SURVEY AREA: Mancos-3

Locality Number:



LOCATION:

State Colorado County Mesa

Township 1N. Range 1E. ; Ute P.M.

C of E½ of E½ of NW ¼, Sec. 8 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Corcoran Point, Colorado,"

1962 , 7.5 min.

UTM 12 ; 715500 mE; 4339000 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, drive north on 27 Road approximately 1.7 miles to east-west intersecting road. Turn east, drive approximately .3 mile to intersecting road. Turn north and drive approximately 1 mile to dirt road, turn west and drive approximately .4 mile. Turn northeast and (staying to the main road on the right) drive approximately 3.9 miles to survey area. Outcrop is in drainage on west side of road.

DESCRIPTION:

Erathem Mesozoic System Cretaceous

Formation Mancos Shale Member

Unit upper Position within Unit grey beds and limestones

Sections worked 30 meters Area surveyed 15 acres

Narrative Survey area composed of grey mudstones with layers of tan sandy limestones evincing large calcite crystals. Steep banks, rills, and stream cuts were prospected, but no fossils were observed. Area was proposed by Dr. Jim Johnson (Geology-Mesa College) as being the possible locality for plesiosaur vertebrae (as shown to him by a student).

RESOURCE POTENTIAL Because of good exposures and the possibility of plesiosaur vertebrae being found in the survey area, there is a good potential for finding vertebrate fossils.

Looking northwest at first area in Mancos Shale surveyed as being likely locality of plesiosaur vertebrae.

BLM Library
Denver Federal Center
Bldg. 85, OC-521
P.O. Box 25047
Denver, CO 80225

SURVEY AREA: Mancos-4

Locality Number:

LOCATION:

State Colorado County Mesa

Township 1N. Range 1E. ; Ute P.M.

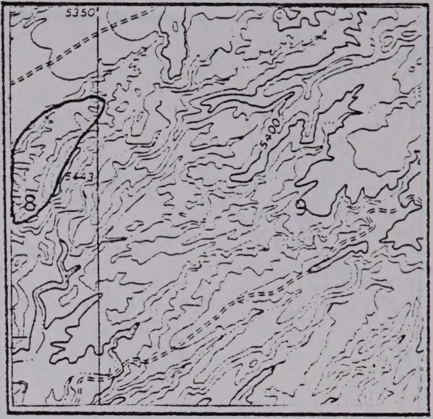
¼ of C of E½ of NE ¼, Sec. 8 ;

¼ of SW ¼ of NW ¼ of NW ¼, Sec. 9 .

U.S.G.S. Quad. "Round Mountain, Colorado," 1962 , 7.5 min.

UTM 12 ; 716500 mE; 4338800 mN

Landowner Bureau of Land Management



ACCESS: From Grand Junction, drive north on 27 Road approximately 1.7 miles to east-west intersecting road, turn east, and drive approximately .3 mile. Turn north, drive approximately 1 mile to dirt road, turn west, drive approximately .4 mile. Turn northeast and, staying to the main road on the right, drive approximately 4.1 miles to survey area. Outcrop is in drainage on east side of road.

DESCRIPTION:

Erathem Mesozoic

System Cretaceous

Formation Mancos Shale

Member

Unit upper

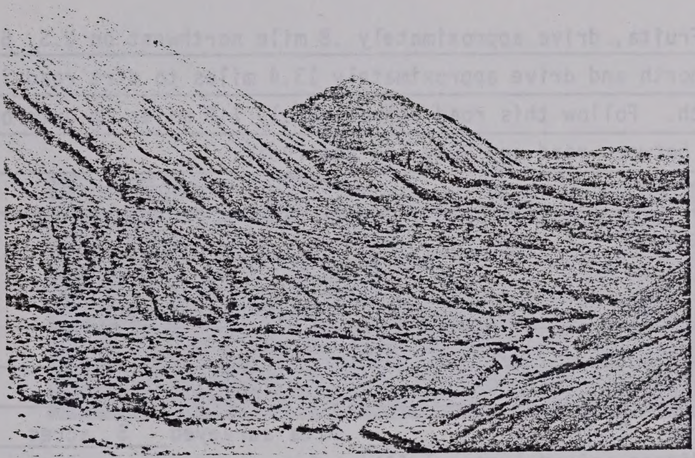
Position within Unit grey beds

Sections worked 30 meters

Area surveyed 30 acres

Narrative Second possible plesiosaur vertebrae locality inspected. Sediments composed of grey mudstones containing layers of calcite crystal enriched, sandy tan limestones. No fossils observed.

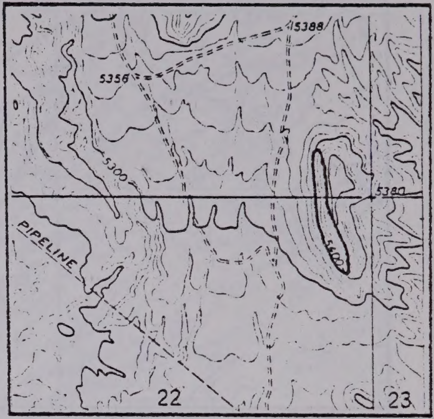
RESOURCE POTENTIAL Because of good exposures and the possibility of pleisiosaur vertebrae being found in the survey area, there is a good potential for finding vertebrate fossils.



Looking southeast at second possible plesiosaur locality exposures in Mancos Shale.

SURVEY AREA: Mancos-5

Locality Number:



LOCATION:

State Colorado County Mesa
Township 8S. Range 102W. ; 6th P.M.
¼ of E½ of NE ¼ of NE ¼, Sec. 22 ;
¼ of SE ¼ of SE ¼ of SE ¼, Sec. 15 .
U.S.G.S. Quad. "Highline Lake, Colorado,"
1968 , 7.5 min.
UTM 12 ; 693600 mE; 4358000 mN
Landowner Bureau of Land Management

ACCESS: From Fruita, drive approximately .8 mile northwest on U.S. 6 & 50 to 16 Road. Turn north and drive approximately 13.4 miles to dirt road intersecting from the north. Follow this road approximately 1.6 miles to outcrop. Outcrop is only hill between road and Ruby Lee Reservoir.

DESCRIPTION:

Erathem Mesozoic
System Cretaceous
Formation Mancos
Member
Unit mudstones
Position within Unit
Sections worked 25 meters
Area surveyed 5 acres

Narrative Bones of a duckbill dinosaur foot were found in this general area in 1970?. They were donated to DMNH without locality data. A local rancher took Lance Eriksen (MWC) to the locality several years ago. This is the only likely exposure for the locality within a 2-mile radius.

RESOURCE POTENTIAL Due to good exposures and good possibility of hill being the duckbill dinosaur locality, good potential exists for vertebrate fossils.

Looking northeast at low hill (center) having possible duckbill dinosaur locality.

SURVEY AREA: Sego-1

Locality Number:

LOCATION:

State Colorado County Garfield

Township 8 S. Range 102 W. ; 6th P.M.

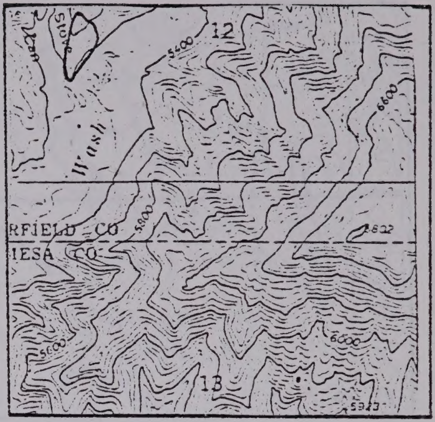
¼ of ¼ of NW ¼ of SW ¼, Sec. 12 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Ruby Lee Reservoir, Colorado", 1968 , 7.5 min.

UTM 12 ; 695400 mE; 4360300 mN

Landowner Bureau of Land Management



ACCESS: From Fruita, Colorado, drive approx. .8 mile northwest on U.S. 6 & 50 to 16 Road. Turn north and drive approx. 15.5 miles to Stove Can Mine road interesection. Outcrop is in middle of fork north of intersection.

DESCRIPTION:

Erathem Mesozoic

System Cretaceous (Mesa Verde Group)

Formation Sego Sandstone

Member

Unit Upper

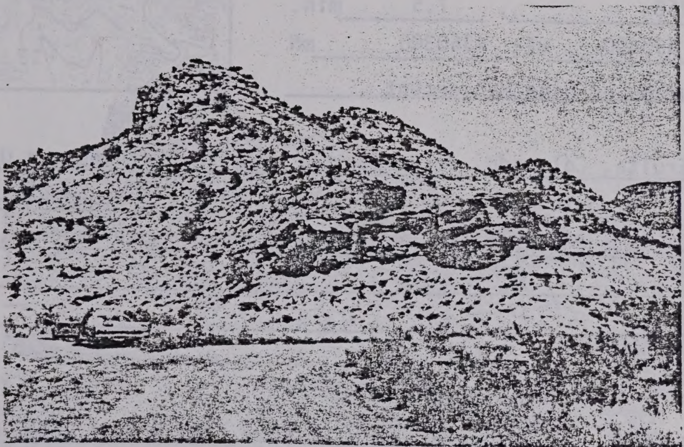
Position within Unit Sandstone Layers

Sections worked 5 m

Area surveyed 5 acres

Narrative Contact of top of Sego Sandstone with bottom of Mt. Garfield Formation was surveyed. The Sego Sandstone outcrops as thin-bedded tan planes which show sedimentary structures and tracks of worms and other invertebrates.

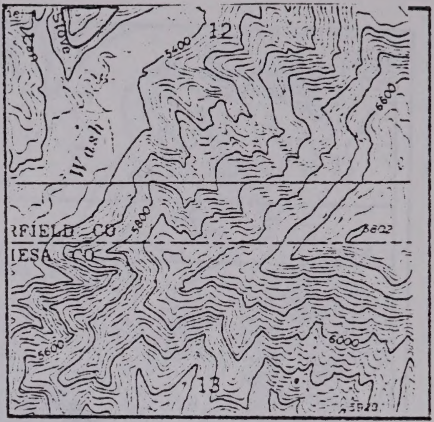
RESOURCE POTENTIAL Due to lack of well-exposed outcrop in the area, potential for vertebrate fossils is low.



Looking north at contact area of Sego Sandstone and Mt. Garfield Formation (above).

SURVEY AREA: Mt. Garfield-1

Locality Number:



LOCATION:

State Colorado County Garfield

Township 8 S. Range 102 W.; 6th P.M.

¼ of ¼ of NW ¼ of SW ¼, Sec. 12 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Ruby Lee Reservoir, Colorado", 1968 , 7.5 min.

UTM 12 ; 695400 mE; 4360300 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, Colorado, drive approx. .8 mile northwest on U.S. 6 & 50 to 16 Road. Turn north and drive approx. 15.5 miles to Stove Can Mine road intersection. Outcrop is in middle of fork north of intersection.

DESCRIPTION:

Erathem Mesozoic

System Cretaceous (Mesaverde Group)

Formation Mt. Garfield

Member

Unit Lower

Position within Unit Sandstone layers

Sections worked 10 m

Area surveyed 5 acres

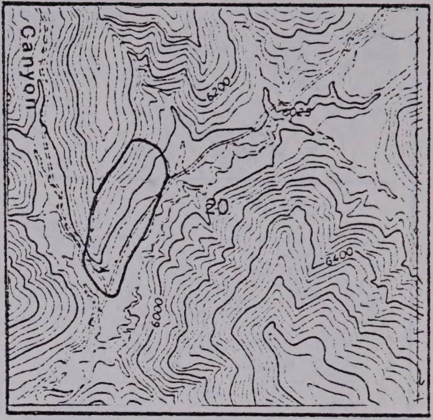
Narrative Contact of bottom of Mt. Garfield Formation with top of Sego Sandstone was surveyed. Mount Garfield Formation outcrops tend to be vertical.

RESOURCE POTENTIAL Due to lack of well-exposed outcrops in the area, potential for vertebrate fossils is low.

Looking north at Mt. Garfield Formation exposures surveyed (above Sego Sandstone bench).

SURVEY AREA: Hunter Canyon-1

Locality Number:



LOCATION:

State Colorado County Garfield

Township 7 S. Range 101 W.; 6th P.M.

¼ of ¼ of C of W½, Sec. 20 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Garvey Canyon, Colorado", 1968 , 7.5 min.

UTM 12 ; 698600 mE; 4367000 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, Colorado, drive approx. .8 mile northwest on U.S. 6 & 50 to 16 Road. Turn north and drive approx. 20.2 miles to Post Canyon road intersection. Outcrop is between fork north of intersection.

DESCRIPTION:

Erathem Mesozoic System Cretaceous (Mesaverde Group)

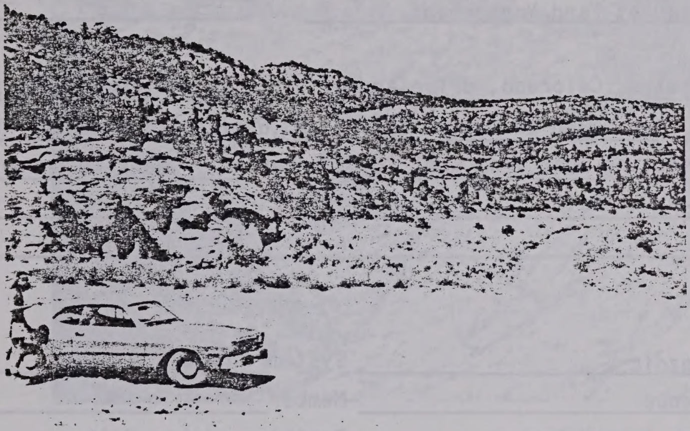
Formation Hunter Canyon Member

Unit Sandstone layers Position within Unit

Sections worked 70 m Area surveyed 25 acres

Narrative Outcrops as vertical exposures of shales covered by sandstone talus. Beds are of massive tan sandstone, thin-bedded sandstone, interbedded shales, and local mudball conglomerates. Thin beds were checked for leaves. No fossils found.

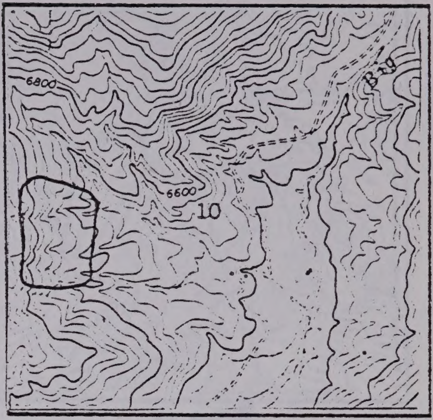
RESOURCE POTENTIAL Low potential for vertebrate fossils exists due to lack of suitable outcrop in the area.



Looking north at exposures surveyed in the Hunter Canyon Formation.

SURVEY AREA: DeBeque-1

Locality Number:



LOCATION:

State Colorado County Garfield

Township 7 S. Range 101 W.; 6th P.M.

¼ of C ¼ of W½ of W½ ¼, Sec. 10;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Garvey Canyon, Colorado", 1968, 7.5 min.

UTM 12; 701500 mE; 4370000 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, Colorado, drive approx. .8 mile northwest on U.S. 6 & 50 to 16 Road. Turn north and drive approx. 23.6 miles (past Cuddy Ranch) to gully intersecting road from west (by two cabins). Walk west approx. 500 m to exposures on hillside.

DESCRIPTION:

Erathem Cenozoic System Eocene

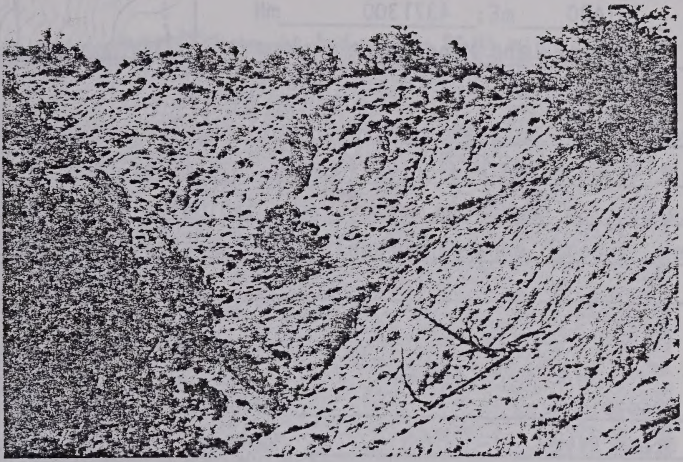
Formation DeBeque Member

Unit Mudstones & sandstones Position within Unit

Sections worked 70 m Area surveyed 30 acres

Narrative Few outcrops occur in this highly vegetated area. Outcrops are on steep hills with exposures of variegated mudstones, local tan-brown grey sandstones, and red grey mudstones.

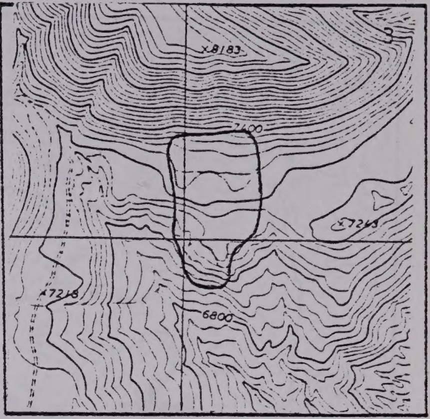
RESOURCE POTENTIAL Some potential exists for finding vertebrate fossils in this area, but outcrops tend to be highly vegetated and no fossils have been found this far west in the formation.



Looking west at steep exposures of the DeBeque Formation survey area.

SURVEY AREA: Green River-1

Locality Number:



LOCATION:

State Colorado County Garfield

Township 7 S. Range 101 W.; 6th P.M.

¼ of NW ¼ of NW ¼ of NW ¼, Sec. 10 ;

¼ of ¼ of SW ¼ of SW ¼, Sec. 3 .

U.S.G.S. Quad. "Garvey Canyon, Colorado", 1968, 7.5 min.

UTM 12 ; 701400 mE; 4371300 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, Colorado, drive approx. .8 mile northwest on U.S. 6 & 50 to 16 Road. Turn north and drive approx. 23.6 miles (past Cuddy Ranch) to gully intersecting road from west (by two cabins). Walk northwest approx. 1300 meters (through dense oakbrush) to survey area.

DESCRIPTION:

Erathem Cenozoic System Eocene

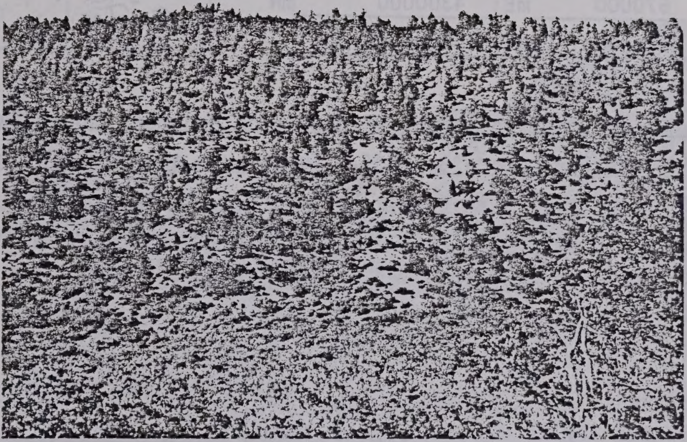
Formation Green River Member Douglas Creek

Unit Entire member Position within Unit

Sections worked 180 m Area surveyed 50 acres

Narrative Steep outcrop and talus of platy grey shale with local sandstones were checked for fossils. No leaves, insects, or other fossils found. Approx. 30 m of outcrop checked as well as 150 m of talus.

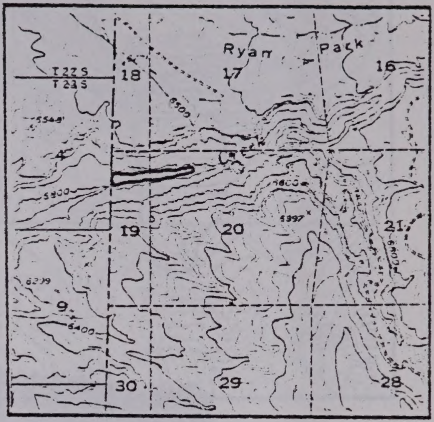
RESOURCE POTENTIAL Area contains some potential for vertebrate fossils but outcrops are extremely weathered and vegetated.



Looking north at exposure of Douglas Creek Member of the Green River Formation area surveyed.

SURVEY AREA: Quaternary-1

Locality Number:



LOCATION:

State Colorado County Mesa

Township 14 S. Range 104 W.; 6th P.M.

¼ of ¼ of ¼ of N½ , Sec. 19 ;

¼ of ¼ of ¼ of N½ , Sec. 20 .

U.S.G.S. Quad. "Coates Creek, Utah-Colo.",

1954 , 15 min.

UTM 12 ; 670000 mE; 4300000 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, drive southwest on Monument Canyon Road approx. .7 mile to Glade Park Store turnoff. Turn south and follow road west approx. 16 miles to fork in road. Follow road approx. 10 miles, head northwest approx. 7.5 miles to fork. Follow southern route approx. 8 miles to fork. Follow east fork approx. 2.5 miles to Granite Canyon rim. Drop into canyon and walk east approx. 2 miles to study area.

DESCRIPTION:

Erathem Cenozoic

System Pleistocene/Holocene

Formation Quaternary Alluviums

Member

Unit Cobbles

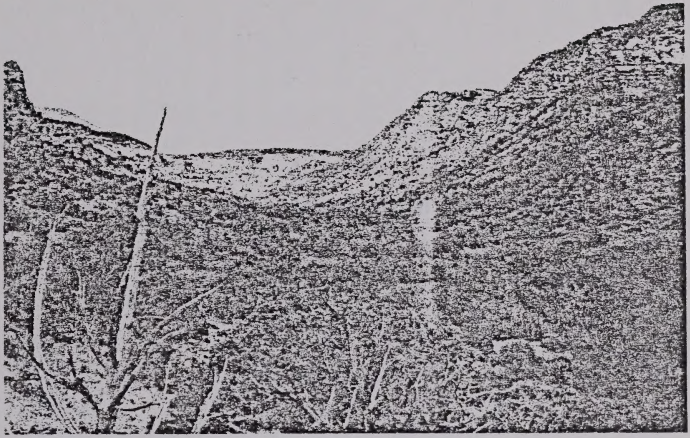
Position within Unit

Sections worked 5 m

Area surveyed 5 acres

Narrative Quaternary creek bed deposits were surveyed in Granite Canyon bottom. Deposits consist of sorted to unsorted boulders, cobbles, sands, and silts. No fossils found, but area holds potential.

RESOURCE POTENTIAL Area holds some potential due to age and intact character of deposits.



Looking east at Granite Canyon from Colorado/Utah border. Quaternary deposits are approximately 5-10 meters thick in creek bottom.

Appendix B
Fossil Localities Within Study Area

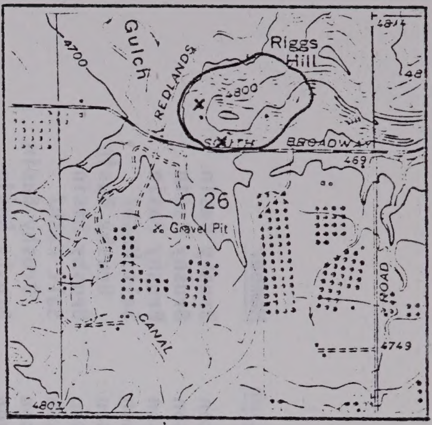
Table of Localities

Locality	Legals		P.M.	Location	Sec.	Formation	Member
8050-1	T11S,	R101W	6th	C E½NW	26	Morrison	Brushy Basin
8050-2	1N,	2W	Ute	NW¼SW¼NE¼NW¼	29	Morrison	Brushy Basin
8050-3	1N,	2W	Ute	SE¼NW¼NW¼NW¼	29	Morrison	Brushy Basin
8050-4	1N,	3W	Ute	S½SW¼SW¼	13	Morrison	Salt Wash/
				N½NW¼	24	Morrison	Brushy Basin
8050-5, 5a	11S	102W	6th	NE¼	27	Morrison	Brushy Basin
8050-6	12S	100W	6th	N½N½	30	Morrison	Salt Wash/
				S½S½	19	Morrison	Brushy Basin
8050-7	1S	1W	Ute	E½NW¼	32	Morrison	Brushy Basin
8050-8	11S	101W	6th	NE¼SE¼NW¼	21	Morrison	Lower Salt Wash
8050-9	1N	2W	Ute	SW¼SE¼	33	Morrison	Lower Salt Wash
8050-10	11S	102W	6th	NW¼	24	Morrison	Brushy Basin
8050-11	11S	102W	6th	SW¼SE¼	24	Morrison	Middle Brushy Basin
8050-12	11S	102W	6th	SE¼SE¼	24	Morrison	Lower Salt Wash
8050-13	11S	102W	6th	NW¼NE¼	36	Morrison	Salt Wash/Br. Basin
8050-14	11S	102W	6th	SW¼SE¼	25	Morrison	Upper Brushy Basin
8050-15	11S	102W	6th	SW¼SE¼	25	Morrison	Upper Mid. Br. Basin
8050-16	11S	102W	6th	NW¼NE¼	36	Morrison	Lower Brushy Basin
8050-17	11S	102W	6th	NW¼NE¼	36	Morrison	Lower Brushy Basin
8050-18	11S	102W	6th	C NW¼SE¼	36	Morrison	Lower Salt Wash
8050-19	11S	102W	6th	NE¼SE¼	36	Morrison	Salt Wash
8050-20	13S	99W	6th	SW¼SW¼SW¼	8	Burro Canyon	
8050-21	1N	1W	Ute			Mancos Shale	
8050-22	2S	1E	Ute			Mancos Shale	
8050-23	8S	102W	6th	E½NE¼NE¼	22	Mancos Shale	
				SE¼SE¼SE¼	15		

LOCALITY NUMBER: 8050-1

NAME: Riggs Hill

Previous Number(s): Quarry #13 - FMNH
Quarry #2 - Holt (1940b)



LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 101 W.; 6th P.M.

___ ¼ of C of E½ of NW ¼, Sec. 26 ;

___ ¼ of ___ ¼ of ___ ¼ of ___ ¼, Sec.___.

U.S.G.S. Quad. "Colorado National Monument, Colorado", 1962, revised 1973 7.5 min.

UTM 12 ; 703200 mE; 4327400 mN

Landowner William Rump

ACCESS: From Grand Junction, travel 4.3 miles northwest on Colorado Highway 340 (Broadway) to South Broadway, which intersects from the southwest. Follow South Broadway 1.0 mile; Riggs Hill lies on the north side of the road.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Brushy Basin

Unit upper portion Position within Unit 50m below Burro Canyon

Narrative Elmer S. Riggs collected parts of a Brachiosaurus altithorax (Riggs 1903a) in 1900 for the Chicago Field Museum. Lee Edward Holt in 1937 quarried three dinosaurs for his University of Colorado master's thesis (specimens were exposed but not collected) (Holt 1940b).

ADDITIONAL INFORMATION:

Sections worked Both quarries were in sandstone layers.

Type specimens Brachiosaurus altithorax Riggs (1903a)

Paleoecological information Partial skeletons with some bones articulated were found. Disarticulation is due to stream action (from southwest) and scavenging.

Known publications Armstrong 1980; Holt 1940a and b; Lohman 1965; Look 1951 and 1955; Pearl 1958 and 1969; Riggs 1901, 1903a, and 1904; Riggs and Farrington 1901a and 1902; Skiff 1909; Young and Young 1977.

LOCALITY NUMBER: 8050-1 Riggs Hill

Phylum: Chordata
Class: Reptilia
Order: Saurischia
Suborder: Theropoda
Family: Megalosauridae

Antrodemus valens, portions of one individual including 1 tooth, 1 metatarsal, 1 scapula, 13 caudal vertebrae, and numerous ribs. The fossil material was described by Holt (1940b), who exposed it in a quarry, hoping to develop an in situ exhibit. The specimen was subsequently vandalized and completely destroyed (Look 1955).

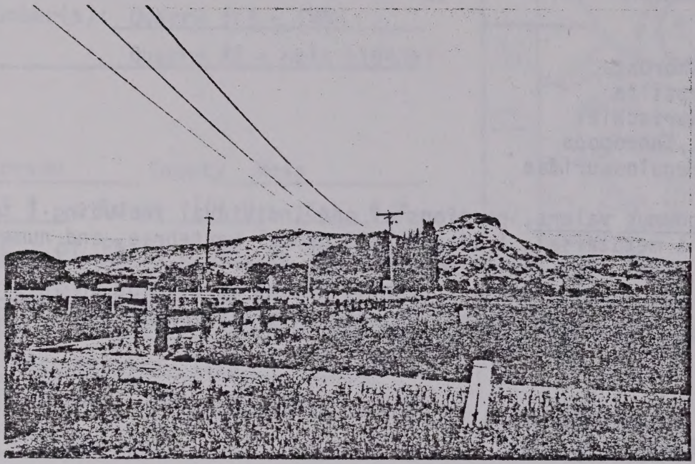
Suborder: Sauropodomorpha
Family: Brachiosauridae

P25107 (CFM) Brachiosaurus altithorax, portions of one individual consisting of the sacrum, parts of the pelvis, 7 presacral vertebrae and 4 or 5 ribs; also humerus, femur, coracoid, and 2 caudal vertebrae. This material was collected in 1900 by Elmer S. Riggs and, designated a new genus and species (Riggs 1903a), is now on exhibit in the Field Museum of Natural History, Chicago.

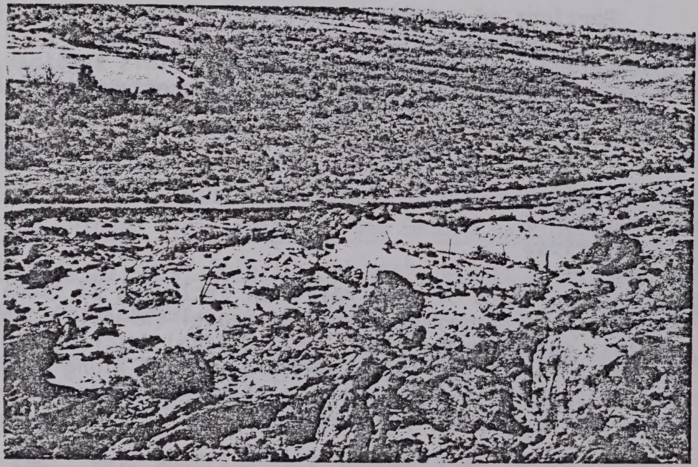
Portions of a second individual represented by 24 caudal vertebrae, two chevron bones, and a tibia were discovered and described by Holt (1940b). This specimen suffered the same fate as the A. valens specimen described above (Look 1955).

Order: Ornithischia
Suborder: Stegosauria
Family: Stegosauridae

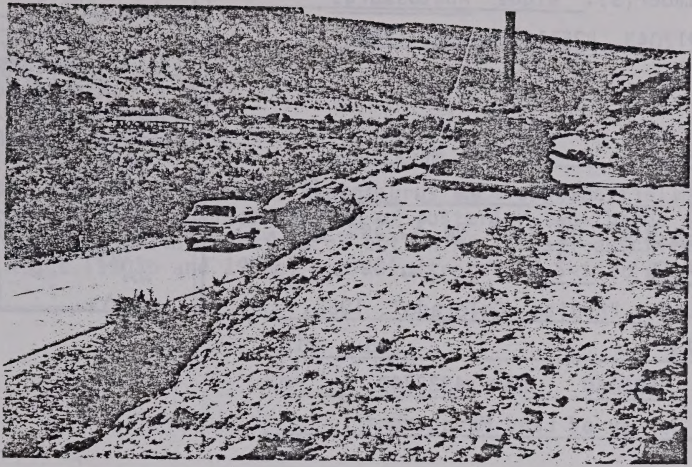
Stegosaurus, portions of one individual including 27 caudal vertebrae, 4 dorsal vertebrae, 4 caudal spines, 2 dermal plates, and numerous ribs. Holt (1940b) described this material, which was subsequently destroyed along with the above listed A. valeus and B. altithorax specimens which were all exposed in the same quarry.



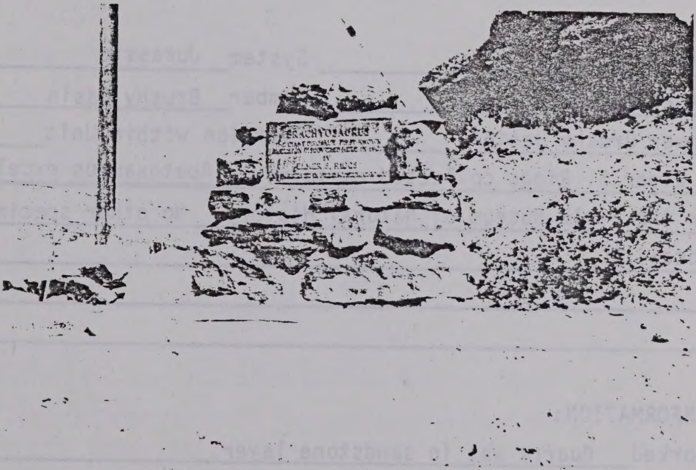
Looking east at Riggs Hill. Riggs and Holt quarries are to the right of hill, below Dakota Sandstone cap.



Looking northwest at Holt quarry (#2) in fenced area. Partial skeletons of Stegosaurus, Allosaurus, and Brachiosaurus were found here in 1937.



Looking southwest at Riggs' Brachiosaurus altithorax quarry (#13). Plaque marks quarry location.


BRACHIOSAURUS

Looking northwest at plaque on Riggs Hill.

LOCALITY NUMBER: 8050-2

NAME: Dinosaur Hill - east end

Previous Number(s): Riggs' Apatosaurus excelsus (P12043, P25112) quarry (FMNH)

LOCATION:

State Colorado County Mesa

Township 1N ; Range 2W ; Ute P.M.

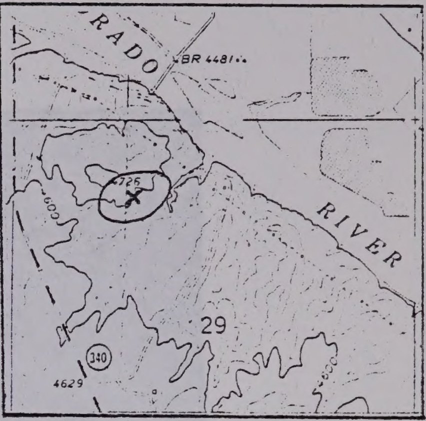
NW ¼ of SW ¼ of NE ¼ of NW ¼, Sec. 29 ;

___ ¼ of ___ ¼ of ___ ¼ of ___ ¼, Sec. ___.

U.S.G.S. Quad. "Fruita, Colorado", 1962, revised 1973 , 7.5 min.

UTM 12 ; 696040 mE; 4333740 mN

Landowner Bureau of Land Management



ACCESS: From Fruita, Colorado, travel south 1.5 miles on Colorado Highway 340. Exposures are on east side of road. Walk approximately 500 meters east from intersection of Hwy 340 and old highway route. Quarry is on SE-facing slope and is marked with a brass plaque set in a stone and cement cairn.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Brushy Basin

Unit Lower Brushy Basin Position within Unit

Narrative Elmer S. Riggs collected parts of an Apatosaurus excelus (Riggs 1903b) in 1901 for the Field Museum of Natural History. No other specimens are known for this locality.

ADDITIONAL INFORMATION:

Sections worked Quarry was in sandstone layer.

Type specimens

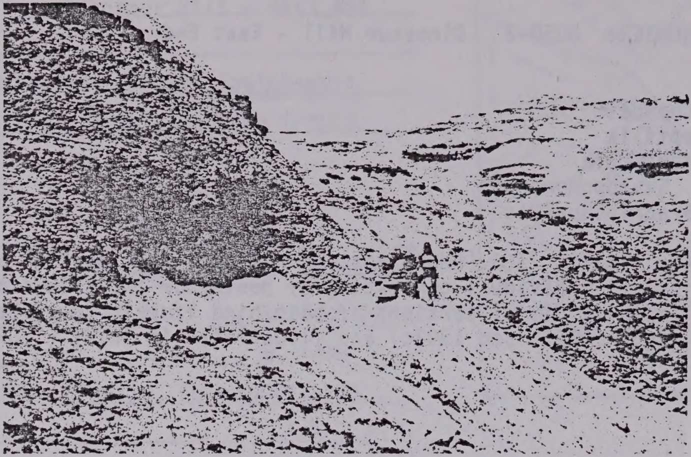
Paleoecological information Bones are articulated, although disassociated posteriorly. Skeleton was probably stream-washed (from SW) and scavenged.

Known publications Armstrong 1980; Holt 1940b; Lohman 1965; Look 1951 and 1955; Moodie 1923; Pearl 1958 and 1969; Riggs 1903b and 1903c; Riggs and Farrington 1901a and 1902; Skiff 1901 and 1909.

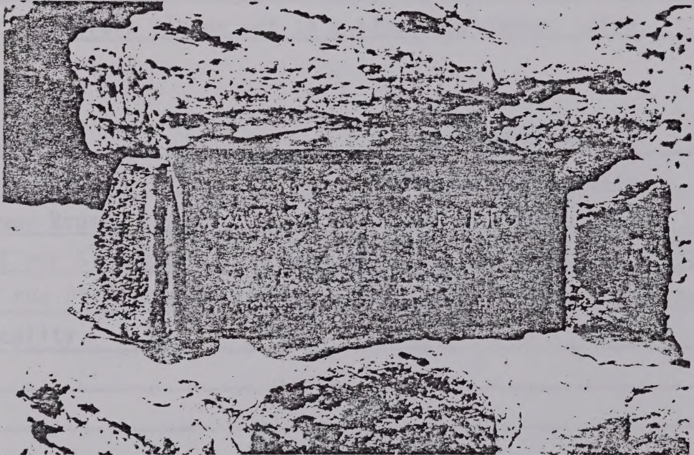
LOCALITY NUMBER: 8050-2 Dinosaur Hill - East End

Phylum: Chordata
Class: Reptilia
Order: Saurischia
Suborder: Sauropodomorpha
Family: Brachiosauridae

P12043, P25112, 7163 (FMNH) Apatosaurus excelsus, partial skeleton of one individual consisting of posterior two-thirds of animal (missing distal portions of both hind limbs), described by Riggs (1903b and 1903c) and illustrated in Skiff (1909).



Looking northwest at Dinosaur Hill. Apatosaurus excelsus quarry is in center foreground.

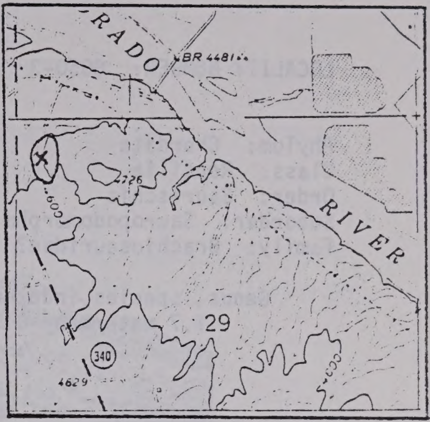


Marker commemorating Apatosaurus find (marker is that by figure in above photograph).

LOCALITY NUMBER: 8050-3

NAME: Dinosaur Hill - west end

Previous Number(s):



LOCATION:

State Colorado County Mesa

Township 1N ; Range 2W ; Ute P.M.

SE ¼ of NW ¼ of NW ¼ of NW ¼, Sec. 29 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Fruita, Colorado", 1962, revised 1973 , 7.5 min.

UTM 12 ; 695650 mE; 4333870 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, Colorado, travel south 1.5 miles on Colorado Highway 340. Boulder with humerus mold is on east side of road, approximately 180 meters northeast from intersection of Hwy 340 and old highway.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Brushy Basin

Unit Lower Brushy Basin Position within Unit 10-15m above Loc. 8050-2

Narrative Humerus mold was found in heavily patinated sandstone boulder. This mold has probably been exposed for at least 50 years and is known by many local people. The mold still contains some fossilized bone. The boulder fell from a sandstone layer overlying (and around the hill from) the *Apatosaurus excelsus* quarry.

ADDITIONAL INFORMATION:

Sections worked sandstone facies

Type specimens

Paleoecological information Mold is in stream sediments.

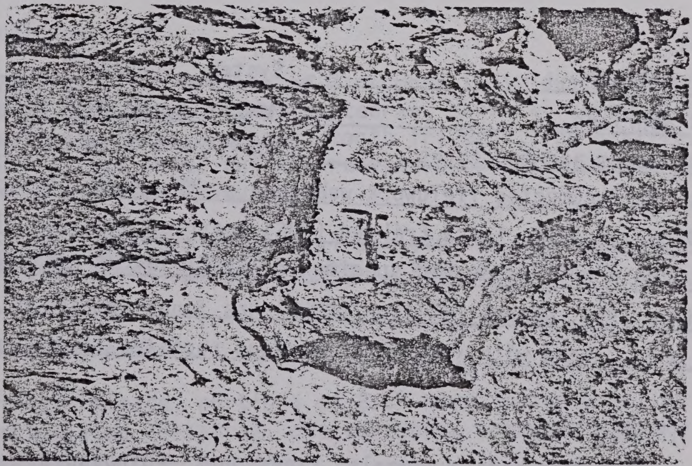
Known publications None.

LOCALITY NUMBER: 8050-3 Dinosaur Hill - West End

Phylum: Chordata
Class: Reptilia
Order: Saurischia
Suborder: Sauropodomorpha
Family: Brachiosauridae?

Genus, species indeterminate, mold of a humerus, approximately 1.7 meters by 0.5 meters.

Looking east at Dinosaur Hill from Highway 340. Boulder with sauropod humerus cast is in center of picture.

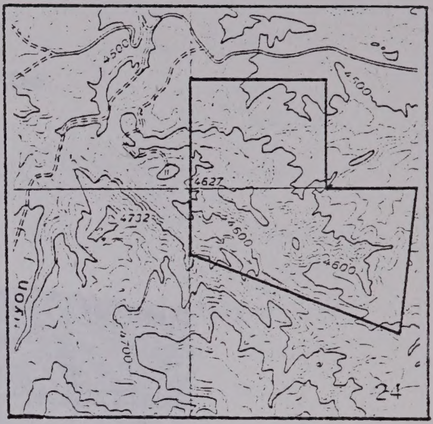


Close-up of sauropod humerus cast (angled away at top).

LOCALITY NUMBER: 8050-4

NAME: Fruita Paleontological Area

Previous Number(s): Quarry I and Quarry II Eriksen (1976).



LOCATION:

State Colorado County Mesa

Township 1N ; Range 3W ; Ute P.M.

of S½ of SW ¼ of SW ¼, Sec. 13 ;

of of N½ of NW ¼, Sec. 24 .

U.S.G.S. Quad. "Mack, Colorado", 1962, revised 1973 , 7.5 min.

UTM 12 ; 692500 mE; 4335500 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, Colorado, travel south approx. 1.3 miles on Colo. Hwy 340. Turn west onto intersecting road and drive approx. 2.0 miles. Turn south/southwest and travel approx. .4 mile to abandoned cabin (within BLM fence). The quarries are in the hills approx. 300m northwest of the cabin.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Upper Salt Wash/Lower Brushy Basin

Unit Sandstones and mudstones Position within Unit Members' contact

Narrative No documented fieldwork was done at the Fruita Paleontological Area prior to 1976. In 1976, Lance Eriksen (MWC) quarried dinosaur elements from the area, including a well-preserved specimen of Ceratosaurus nasicornis (including skull). Since 1976, George Callison (CULB) has found remains of very early mammals in the red beds, along with remains of various reptiles (including dinosaurs).

ADDITIONAL INFORMATION:

Sections worked Red beds → mammals, sandstones → dinosaurs

Type specimens (See following faunal list provided by Callison and Rasmussen.)

Paleoecological information Mammals and small reptiles found in flood plain deposits; dinosaurs found in stream channel deposits (Eriksen 1978).

Known publications BLM 1977; Callison 1976; Clemens et al. 1979; Eriksen 1976 and 1978; Rasmussen and Callison (in press).

LOCALITY NUMBER: 8050-4 Fruita Paleontological Area
Collections of MWC by Lance Eriksen (1976 and 1978)

Phylum: Chordata
Class: Reptilia
Order: Chelonia

Genus indeterminate, turtle scute impression in sandstone.

Order: Crocodilia

Genus indeterminate. Consists of two caudal vertebrae centra.

Order: Saurischia

Genus indeterminate, several individuals. Materials include vertebrae, vertebrae in matrix, small claw with tip missing, one vertebrae chevron.

Suborder: Theropoda

Genus indeterminate. One tooth.

Family: Megalosauridae

Antrodemus valens, portions of 2 or more individuals including toe bones, one claw, caudal vertebrae, cervical vertebrae, atlas vertebra, axis vertebrae, tooth fragment, and maxilla. The maxilla was noted but was removed by vandals before it could be scientifically quarried.

Ceratosaurus nasicornis, partial skeleton of one individual, including a well-preserved skull, limb bones, ribs, and vertebrae.

Suborder: Sauropodomorpha

Genus indeterminate, portions of 2 or more individuals including four articulated vertebrae, one vertebrae chevron, and one partial tooth.

Family: Brachiosauridae

cf. *Apatosaurus*, one tooth

Brachiosaurus, one complete femur

Order: Ornithischia
Suborder: Stegosauria
Family: Stegosauridae

Stegosaurus, portions of one individual including vertebrae, pubis, tibia, femur, scapula, and coracoid.

The following faunal list, provided by George Callison and T. E. Rasmussen, covers specimens now under study by individuals at the California State University, Long Beach, and the University of California, Berkeley. It is reprinted here with the permission of the authors.

FAUNAL LIST
FRUITA PALEONTOLOGICAL AREA

S½ Sec. 13, N½ Sec. 24, T.1N., R.3W.,
Ute P.M., Mesa County, Colorado

Late Jurassic, Morrison Formation

Compiled by:
George Callison and T. E. Rasmussen

Department of Biology
California State University
Long Beach, California 90840

Numbers are those of the Natural History Museum of Los Angeles County--LACM, Vertebrate Paleontology Collections. CFP = Callison Field Party, followed by the year. Numbers in parentheses are field numbers.

Class Mammalia
Subclass Allotheria
Order Multitiberculata
Suborder Plagiaulacoidea
Family (New family) Callison, 1980

120453 (MN79-59) -- New genus and new species Callison, 1980
Sublocality -- Locality Number 4
Material -- Holotype. Entire snout with dentition, left zygoma; snout in two parts; dentition well preserved.
Date collected -- July 1979
Collected by -- CFP79
Identified by -- G. L. Callison

120458 (MN79-59, block 6a) -- cf. New genus (120453)
Sublocality -- Locality Number 4
Material -- Fragment of right maxilla with four teeth and partial zygoma; teeth fairly well preserved.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- G. L. Callison

Family Plagiaulacidae

120452 (MN79-59) -- *Ctenacodon* (?*Psalodon*) sp.
Sublocality -- Locality Number 4
Material -- Right mandible with dentition.
Date collected -- July 1979
Collected by -- CFP79
Identified by -- G. L. Callison

120463 (MN79-59) -- *Ctenacodon* or *Psalodon* sp.
Sublocality -- Locality Number 4
Material -- Left mandible with separate canine in wax, four teeth present on mandible.
Date collected -- July 1979
Collected by -- CFP79
Identified by -- T. E. Rasmussen

Subclass Eotheria
Order Triconodonta
Family Triconodontidae

120451 (Erin mammal block) -- Priacodon new species Rasmussen and Callison, 1980
Sublocality -- Locality Number 4
Material -- Holotype. Lower left jaw in matrix, part and counterpart, with all premolars and molars and canine, and alveoli for two incisors; right mandible with all teeth except incisors; right maxilla with all teeth and palate; left maxilla with all teeth and palate; part of braincase with petrosal; right humerus; both radii, a phalanx; and several vertebrae. All material in excellent condition.
Date collected -- July 1979
Collected by -- Erin Flanagan
Identified by -- T. E. Rasmussen

120460 -- cf. Priacodon sp.
Sublocality -- Rhynch. Number 1, Locality Number 2
Material -- Fragment of right dentary with last premolar and two adjacent teeth.
Date collected -- Summer 1976
Collected by -- G. L. Callison
Identified by -- G. L. Callison

Triconodonta affina

120518 -- Triconodonta affina
Sublocality -- Locality Number 4
Material -- Humerus and femur.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- T. E. Fasmussen

Subclass Theria
Infraclass Pantotheria
Order Symmetrodonta
Family Spalacotheridae

120459 (MN79-59, block 6a) -- cf. Tinodon
Sublocality -- Locality Number 4
Material -- Anterior end of lower right jaw.
Date collected -- July 1979
Collected by -- CFP79
Identified by -- T. E. Fasmussen

Order Eupantotheria
Family Dryolestidae

120461 -- cf. dryolestid
Sublocality -- Locality Number 5, Norell Mammal

Material --Fragment of left dentary with teeth.
Date collected -- August 1977
Collected by -- CFP77
Identified by -- G. L. Callison

120457 -- cf. dryolestid
Sublocality -- Locality Number 4
Material -- Right maxilla with posteriormost six cheek teeth and associated right mandible.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- G. L. Callison

Eupantotheria affina

120454 -- ? Affinities within the Eupantotheria
Sublocality -- Locality Number 4
Material -- Entire snouth with dentition.
Date collected -- July 1979
Collected by -- CFP79
Identified by -- G. L. Callison

Mammalia affina

115743 -- Mammalia affina
Sublocality -- Locality Number 2
Material -- Two fragments of left dentary with alveoli and tooth fragments.
Date collected -- July 1975
Collected by -- G. L. Callison
Identified by -- G. L. Callison

120517 -- Mammalia affina
Sublocality -- Locality Number 4
Material -- Palate with dentition.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by --

Class Reptilia
Subclass Anapsida
Order Testudines
Suborder Casichelydia
Infraorder Cryptodira
Superfamily Baenoidia
Family Glyptopsidae

115738 -- cf. Glyptops sp.
Sublocality -- Locality Number 2
Material -- Six shell framents.

Date collected -- July 1975
Collected by -- CFP75
Identified by -- G. L. Callison

115742 -- cf. *Glyptops* sp.
Sublocality -- JMC77-5a, Opal Hill
Material -- Shell fragments.
Date collected -- July 1975
Collected by -- J. M. Clark
Identified by -- J. M. Clark

120464 (CS79F2) -- cf. *Glyptops* sp.
Sublocality -- Channel
Material -- Shell fragments.
Date collected -- July/August 1979
Collected by -- C. Stadum
Identified by -- T. E. Rasmussen

120465 -- cf. *Glyptops* sp.
Sublocality -- Locality Number 4
Material -- Shell fragments.
Date collected -- July/August 1979
Collected by -- M. A. Norell
Identified by -- T. E. Rasmussen

120466 -- cf. *Glyptops* sp.
Sublocality -- Locality Number 4
Material -- Shell fragments.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- G. L. Callison

Subclass Lepidosauria
Order Squamata
Suborder Sphenodontia
Family Sphenodontidae
Subfamily Sphenodontinae

115746 (JMC77-11a) -- cf. *Opisthias* sp.
Sublocality -- Locality Number 6
Material -- Fragment of left mandible.
Date collected -- August 1977
Collected by -- J. M. Clark
Identified by -- G. L. Callison

120467 (MN79-59) -- cf. *Opisthias* sp.
Sublocality -- Locality Number 4
Material -- Entire left mandible with dentition.
Date collected -- July/August 1979
Collected by -- CFP79

Identified by -- T. E. Rasmussen

120468 (JMC79-18) -- cf. Opisthias sp.
Sublocality -- Locality Number 4
Material -- Fragment of left mandible.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- T. E. Rasmussen

120469 (MN79-59, block 6a) -- cf. Opisthias
Sublocality -- Locality Number 4
Material -- Most of the right mandible of a juvenile.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- T. E. Rasmussen

120476 (JMC79-18) -- cf. Opisthias
Sublocality -- Locality Number 4
Material -- Jaw fragments.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- T. E. Rasmussen

New Subfamily

115729 -- cf. New genus (120462)
Sublocality -- Locality Number 5
Material -- Vertebra.
Date collected -- August 1977
Collected by -- G. L. Callison
Identified by -- T. E. Rasmussen

115733 -- New genus, new species (same as 120462)
Sublocality -- Number 5, West
Material -- Fragment of right mandible with posterior five teeth.
Date collected -- August 1977
Collected by -- S. R. May
Identified by -- T. E. Rasmussen

115735 -- New genus, new species (same as 120462)
Sublocality -- Locality Number 2
Material -- Associated limb and foot elements; maxillary fragment with maxillary and palatine teeth; vertebrae; many bone fragments; good material.
Date collected -- July 1976
Collected by -- CFP76
Identified by -- T. E. Rasmussen

115736 (JMC75-1) -- cf. (same as 120462)
Sublocality -- Locality Number 2

Material -- Left femur.
Date collected -- July 1975
Collected by -- J. M. Clark
Identified by -- G. L. Callison

120462 -- New genus and new species Rasmussen and Callison, 1980
Sublocality -- Productive horizon East of Bulldozer ridge
Material -- Holotype. Both right and left posterior halves of mandibles; including ten teeth on left mandible and seven on right mandible; right quadrate; quadratojugal; vertebrae; scapula; parts of limb bones.
Date collected -- July 1976
Collected by -- CFP76
Identified by -- T. E. Rasmussen

120470 -- (same as 120462)
Sublocality -- Productive horizon East of Bulldozer ridge
Material -- Left maxilla with palatine and maxillary teeth.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- T. E. Rasmussen

120471 (MN79-59) -- cf. (120462)
Sublocality -- Rhynch. Number 1
Material -- Posterior left mandible, no teeth; bone fragments.
Date collected -- July 1977
Collected by -- S. R. May
Identified by -- T. E. Rasmussen

120472 (GLC79-11) -- cf. (120462)
Sublocality -- Productive horizon between Number 25 and 27
Material -- Fragment of left mandible with teeth; several vertebrae; bone fragments.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- T. E. Rasmussen

120473 -- cf. (120462)
Sublocality -- Locality Number 5, East
Material -- Skull, limb and vertebrae fragments.
Date collected -- August 1977
Collected by -- S. R. May
Identified by -- G. L. Callison

120474 -- (same as 120462)
Sublocality -- Locality Number 5, West
Material -- Right mandible fragments with teeth.
Date collected -- J. M. Clark
Collected by -- J. M. Clark

Identified by -- T. E. Rasmussen

120475 -- (same as 120462)
Sublocality -- Locality Number 5
Material -- Maxillary fragment with teeth.
Date collected -- August 1976
Collected by -- J. M. Clark
Identified by -- T. E. Rasmussen

Suborder Lacertilia
Lacertilia affina

120506 (MN79-59) -- Lacertilia affina
Sublocality -- Locality Number 4
Material -- Occiput.
Date collected -- July/August 1979
Collected by -- M. A. Norell
Identified by -- T. E. Rasmussen

120507 (GLC79-10) -- Lacertilia affina
Sublocality -- Between 25 and 29
Material -- Vertebra.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- T. E. Rasmussen

120515 -- Lacertilia affina
Sublocality -- Locality Number 4
Materail -- Vertebra.
Date collected -- July/August 1979
Collected by -- J. M. Clark
Identified by -- T. E. Rasmussen

Subclass Archosauria
Order Crocodilia
Suborder Mesosuchia

115726 -- New genus, new species of mesosuchian A
Sublocality -- SW of Lazy Lizard, just East and three meters below JMC 77-7a.
Material -- Associated skull and skeletal fragments.
Date collected -- August 1977
Collected by -- S. R. May
Identified by -- J. M. Clark

115730 -- Mesosuchian crocodile
Sublocality -- Locality Number 6
Material -- Dentary fragments; associated limb bone material; metatarsals; phalanges; rib fragments.

A lot of material.
Date collected -- August 1977
Collected by -- S. R. May
Identified by -- G. L. Callison

115732 -- New genus, new species of mesosuchian A
Sublocality -- Locality Number 4
Material -- Maxillary fragments. Probably same specimen as LACM 115726.
Date collected -- August 1977
Collected by -- S. R. May
Identified by -- J. M. Clark

115737 -- New genus, new species of mesosuchian A
Sublocality -- Locality Number 4, Lazy Lizard
Material -- Block with cervical vertebrae; rear of skull; left humerus; ulna fragments.
Date collected -- July 1975
Collected by -- J. M. Clark and G. L. Callison
Identified by -- J. M. Clark

115741 (JMC 77-5a) -- Mesosuchian, probably goniopholid
Sublocality -- South face of Opal Hill
Material -- Two teeth.
Date collected -- July 1977
Collected by -- J. M. Clark
Identified by -- J. M. Clark

115745 (JMC 77-Bal) -- New genus, new species of mesosuchian A
Sublocality -- Directly above JMC 77-8a2
Material -- Maxillary, premaxillary and limb fragments.
Date collected -- August 1977
Collected by -- J. M. Clark
Identified by -- J. M. Clark

120455 -- New genus, new species of mesosuchian A
Sublocality -- Locality Number 4
Material -- Holotype. Semi-articulated skeleton with skull.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- J. M. Clark

120456 -- New genus, new species of mesosuchian A
Sublocality -- Locality Number 4
Material -- Block with jaws, skull fragments, two radii, one ulna, associated bone fragments.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- J. M. Clark

120485 -- Mesosuchian (goniopholid)
Sublocality -- Channel sandstone
Material -- Vertebrae and scutes.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- J. M. Clark

120492 -- New genus, new species of mesosuchian A
Sublocality -- Locality Number 4
Material -- Small skull.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- J. M. Clark

Order Pterosauria
Order Saurischia
Suborder Theropoda
Infraorder Coelurosauria
Family Coelurosauridae

115727 -- cf. Coelurosaurus
Sublocality -- Locality Number 4
Material -- Associated skeletal material. A lot of material.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- G. L. Callison

115744 (JMC77-8a2) -- cf. Coelurosaurus
Sublocality -- Locality Number 4
Material -- Associated skeletal material; many fragments of limb bones.
Date collected -- August 1977
Collected by -- CFP77
Identified by -- G. L. Callison

120477 (GLC79-21) -- cf. coelurid
Sublocality -- Locality Number 4
Material -- Distal tibiotarsus.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- G. L. Callison

120478 -- cf. Coelurosaurus
Sublocality -- Locality Number 4
Material -- Associated tibia and fibula; most of the distal femur with fourth trochanter; humerus.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- G. L. Callison

Infraorder Carnosauria
Carnosauria affina

120484 -- Carnosaur
Sublocality -- Three meters above Norell Mammal, Locality Number 6
Material -- Tooth fragments.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- J. M. Clark

Family Megalosauridae

120513 -- Megalosaurid
Sublocality -- 50 meters SW of *Ceratosaurus*
Material -- Tooth.
Date collected -- August 1977
Collected by -- G. L. Callison
Identified by -- G. L. Callison

120516 -- Megalosaurid
Sublocality -- Locality Number 4
Material -- Tooth with replacement tooth.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by -- G. L. Callison

Theropoda affina

115734 -- Theropoda affina
Sublocality -- Locality Number 6
Material -- Tooth.
Date collected -- August 1977
Collected by -- G. L. Callison
Identified by -- G. L. Callison

Suborder Sauropodomorpha
Infraorder Sauropoda
Family Brachiosauridae

120508 -- *Camarasaurus*
Sublocality -- 100 yards SW of Lazy Lizard
Material -- Fragment of scapula.
Date collected -- August 1977
Collected by -- S. R. May
Identified by -- M. A. Norell

120509 -- *Camarasaurus*
Sublocality -- Just East of second saddle of productive horizon

Material -- Tooth.
Date collected -- August 1977
Collected by -- G. L. Callison
Identified by -- G. L. Callison

120511 -- *Camarasaurus*
Sublocality -- 50 meters SW of *Ceratosaurus*
Material -- Tooth.
Date collected -- August 1977
Collected by -- G. L. Callison
Identified by -- G. L. Callison

Sauropoda affina

120510 -- Sauropoda affina
Sublocality -- 50 meters SW of *Ceratosaurus*
Material -- Tooth.
Date collected -- August 1977
Collected by -- G. L. Callison
Identified by -- G. L. Callison

120512 -- Sauropoda affina
Sublocality -- 50 meters SW of *Ceratosaurus*
Material -- Tooth.
Date collected -- August 1977
Collected by -- G. L. Callison
Identified by -- G. L. Callison

Order Ornithischia
Suborder Ornithopoda
Family Hypsilophodontidae

115747 (JMC77-7a) -- cf. *Fabrosaurus*
Sublocality -- Locality Number 4
Material -- Mandible fragment; fragment of maxilla; vertebrae; various limb fragments.
Date collected -- August 1977
Collected by -- J. M. Clark
Identified by -- G. L. Callison

Suborder stegosauria
Family Stegosauridae

120514 -- cf. *Stegosaurus*
Sublocality -- Stegosaur osteoderm site
Material -- Osteoderm.
Date collected -- August 1977
Collected by -- G. L. Callison
Identified by -- G. L. Callison

Reptilia affina

115731 -- Reptilia affina
Sublocality -- Locality Number 6
Material -- Two eggs.
Date collected -- August 1977
Collected by -- S. R. May
Identified by -- G. L. Callison

120479 (GLC 79-5) -- Reptilia affina
Sublocality -- Locality Number 4
Material -- Vertebra.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by --

120480 (GLC 79-7) -- Reptilia affina
Sublocality -- Locality Number 4
Material -- Scute.
Date collected -- July/August 1979
Collected by -- CFP79
Identified by --

120481 (JMC 77-8a2) -- Reptilia affina
Sublocality -- Locality Number 4 on East side of ridge
Material -- Reptilian foot bones.
Date collected -- July 1977
Collected by -- J. M. Clark
Identified by -- J. M. Clark

120482 (JMC 79-13) -- Reptilia affina
Sublocality -- Locality Number 4
Material -- Amphicoelous, ? notochordal vertebra.
Date collected -- July/August 1979
Collected by -- J. M. Clark
Identified by --

120483 (JMC 79-15a) -- Reptilia affina
Sublocality -- Three meters above Norell Mammal,
Locality Number 6
Material -- Fragmentary skeleton.
Date collected -- July/August 1979
Collected by -- J. M. Clark
Identified by --

120486 (JMC 79-22) -- Reptilia affina
Sublocality -- Locality Number 4
Material -- Vertebra.
Date collected -- July/August 1979
Collected by -- J. M. Clark
Identified by --

120487 -- Reptilia affina
Sublocality -- Locality Number 4
Material -- Maxillary.
Date collected -- July/August 1979
Collected by -- M. A. Norell
Identified by --

120488 (MN 79-56) -- Reptilia affina
Sublocality -- Locality Number 4
Material -- ? Dinosaur skull fragments.
Date collected -- July/August 1979
Collected by -- M. A. Norell
Identified by --

120489 (CS79F1) -- Reptilia affina
Sublocality -- CS79F1
Material -- Distal femur, ? croc.
Date collected -- July/August 1979
Collected by -- C. Stadum
Identified by --

120490 -- Reptilia affina
Sublocality -- 80 yards SW of Lazy Lizard, near JMC 77-8a2
Material -- Vertebra, ? lizard.
Date collected -- August 1977
Collected by -- S. R. May
Identified by --

120491 -- Reptilia affina
Sublocality -- Croc. Turtle Clam Site
Material -- Premaxillary, dentary fragments, some bones.
Date collected -- August 1977
Collected by -- M. A. Norell
Identified by --

120493 -- Reptilia affina
Sublocality -- Norell Mammal
Material -- Fused frontals (not croc.) and croc. skull fragments, reptile vertebrae.
Date collected -- August 1977
Collected by -- M. A. Norell
Identified by --

120494 -- Reptilia affina
Sublocality --
Material -- Skull.
Date collected -- August 1977
Collected by -- S. R. May
Identified by --

Class Osteichthys

115740 -- Osteichthys
Sublocality -- Opal Hill
Material -- Two vertebrae.
Date collected -- July 1977
Collected by -- J. M. Clark
Identified by -- G. L. Callison

Miscellaneous

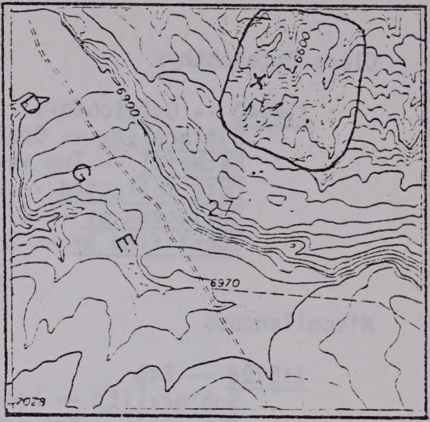
115728 -- Egg
Sublocality -- Locality Number 5
Material -- One egg, small lizard-like.
Date collected -- August 1977
Collected by -- G. L. Callison
Identified by -- G. L. Callison

115739 (JMC77-5a) -- Coprolite
Sublocality -- Opal Hill
Material -- One coprolite.
Collected by -- J. M. Clark
Identified by -- G. O. Callison

LOCALITY NUMBER: 8050-5 and 8050-5a

NAME: Black Ridge and Tooth Locality

Previous Number(s): None



LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 102 W. ; 6th P.M.

¼ of ¼ of ¼ of NE ¼, Sec. 27 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. "Battleship Rock, Colo.",

1962 , 7.5 min.

UTM 12 ; 692380 mE; 4327200 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, Colorado, drive south on Colorado Hwy 340 approx. 2.4 miles to CNM road. Turn south, drive approx. 8.5 miles to Glade Park Store turnoff. Turn west, drive approx. 1.2 miles to road intersecting from NW. Follow this rough dirt road approx. 1.3 miles to road intersecting from NE. Drive approx. 1 mile, turn west and drive approx. 1.1 miles. Walk north approx. 250 meters to top of locality.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Brushy Basin

Unit Position within Unit

Narrative This locality may be more extensive than area surveyed for report. Bone, petrified wood, and probable coprolities are common. Sublocality 8050-5a is a small knoll where 5 teeth were found. A sauropod humerus was found in the vicinity by a local rock collector.

ADDITIONAL INFORMATION:

Sections worked 50m. of upper Brushy Basin

Type specimens None

Paleoecological information Some bone (fragmented) found in situ in red bed flood plain deposits. Teeth and other bone were surface-collected.

Known publications None.

LOCALITY NUMBER: 8050-5 Black Ridge 8050-5a Tooth Locality

Phylum: Chordata
Class: Reptilia
Order: Crocodilia

Genus indeterminate, one tooth.

Order: Saurischia
Suborder: Theropoda

Genus indeterminate, two limb bone fragments.

Family: Megalosauridae

Antrodemus valens, two anterior teeth.

Ceratosaurus nasicornis, one tooth tip, one tooth edge.

These specimens are waiting to be catalogued into the University of Colorado Museum.

Looking south at Black Ridge Locality.

Red beds with bone in situ to left of hammer, 5 meters above Black Ridge Tooth Locality.

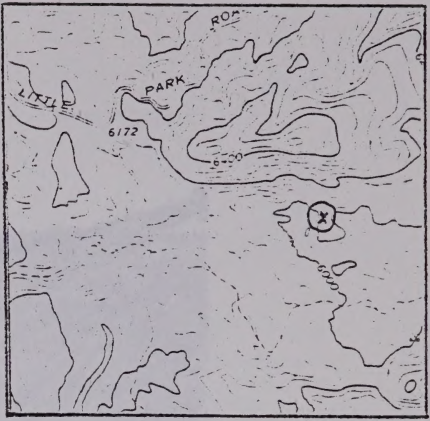
Looking north at the Black Ridge Tooth Locality. Figures are on knoll where teeth were found.

Two pieces of theropod limb bone in situ.

LOCALITY NUMBER: 8050-6

NAME: Little Park Road Locality

Previous Number(s): None



LOCATION:

State Colorado County Mesa

Township 12 S. ; Range 100 W. ; 6th P.M.

of of N½ of N½ , Sec. 30 ;

of of S½ of S½ , Sec. 19 .

U.S.G.S. Quad. "Island Mesa, Colorado", 1969, 7.5 min.

UTM 12 ; 707080 mE; 4317920 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, drive 1 mile south on Colo. Hwy 50 to traffic intersection. Turn south, follow road around cemetery approx. .6 mile, turn north, and drive approx. .7 mile (cross Gunnison River) to intersection with Little Park Road. Follow L. P. Road approx. 5.6 miles to dirt road intersecting from the south. Walk approx. 400 meters east/southeast to exposures.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Salt Wash/Brushy Basin

Unit Upper Salt Wash/Lower Brushy Basin Position within Unit contact area.

Narrative Nondiagnostic scraps of small bone were noted. This area closely resembles the Fruita Paleontological Area and, as such, has a potential for producing early mammals and associated reptiles.

ADDITIONAL INFORMATION:

Sections worked Sandstones and red mudstones.

Type specimens None.

Paleoecological information Bone washed from rills onto flat areas. No in situ bone spotted.

Known publications None.

LOCALITY NUMBER: 8050-6 Little Park Road Locality

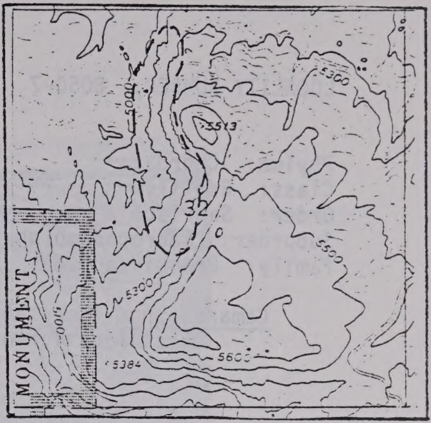
Numerous non-diagnostic fragments of bone were observed. This area is of interest because it is fossiliferous, has the potential of producing diagnostic specimens, and closely resembles the red beds at the Fruita Paleontological Area.

Looking west at western portion of Little Park Road Locality from area of bone occurrence.

LOCALITY NUMBER: 8050-7

NAME: Riggs' Morosaurus Locality

Previous Number(s): Quarry #14 (FMNH)



LOCATION: Uncertain, but in the area of:

State Colorado County Mesa

Township 1 S. ; Range 1 W. ; Ute P.M.

___¼ of ___¼ of E½ of NW¼ , Sec. 32 ;

___¼ of ___¼ of ___¼ of ___¼, Sec.___.

U.S.G.S. Quad. "Grand Junction, Colorado", 1962, photorevised 1973 , 7.5 min.

UTM 12 ; 706200 mE; 4322750 mN

Landowner Bureau of Land Management

ACCESS: From Grand Junction, Colorado, drive southwest approx. 4.0 miles on the road to Colorado National Monument. Park by entrance to Devil's Kitchen Picnic Area. Walk approximately 1000 meters east to high, most suspect exposures.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Brushy Basin

Unit green shale Position within Unit upper

Narrative In 1900, Riggs and Farrington (1901b) found a foreleg of a "Morosaurus grandis (now called Camarasaurus grandis) at "the base of the Serpent's Trail in Colorado National Monument". There are only two possible exposures within three miles of the area; both are within 1 mile of the base of the Serpent's Trail. The exposures to the west (legals given above) seem the most likely area for the locality.

ADDITIONAL INFORMATION:

Sections worked Green shale beds.

Type specimens None.

Paleoecological information Probably stream deposits/flood plain deposits (bones were either articulated or in close association).

Known publications Look 1951 and 1955; Riggs and Farrington 1901b; Skiff 1901.

LOCALITY NUMBER: 8050-7 Riggs' Morosaurus Locality

Phylum: Chordata
Class: Reptilia
Order: Saurischia
Suborder: Sauropodomorpha
Family: Brachiosauridae

Camarasaurus (Morasaurus) grandis, fore leg of one individual. Exact location of locality is unknown.

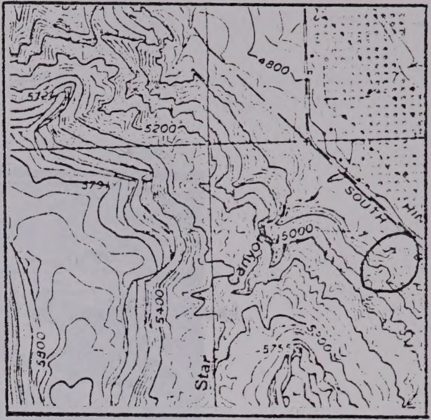
Looking north at least likely area for the Camarasaurus (Morosaurus) grandis locality.

Looking east at most likely area for the Camarasaurus (Morosaurus) grandis locality.

LOCALITY NUMBER: 8050-8

NAME:

Previous Number(s): Locality 2 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 101 W.; 6th P.M.

¼ of NE ¼ of SE ¼ of NW ¼, Sec. 21 ;

¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973 , 7.5 min.

UTM 12 ; 700750 mE; 4328900 mN

Landowner National Park Service

ACCESS: From Grand Junction, travel 4.3 miles west on Hwy 340 to South Broadway. Follow South Broadway 4 miles west, stopping at National Monument gate. Locality is approximately 100m west.

DESCRIPTION:

Erathem Mesozoic

System Jurassic

Formation Morrison

Member Lower Salt Wash

Unit

Position within Unit

Narrative George L. Callison found fragmented pieces of bone, probably dinosaur (Callison 1977).

ADDITIONAL INFORMATION:

Sections worked Unspecified.

Type specimens None.

Paleoecological information River deposited sandstones/flood plain alluvium.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-8

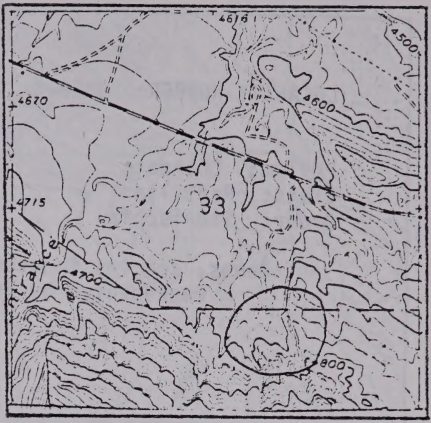
Phylum: Chordata
Class: Reptilia
Order: Saurischia

Genus, species indeterminate, portions of one or more individuals represented by fragmented bone.

LOCALITY NUMBER: 8050-9

NAME:

Previous Number(s): Locality 3 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 1 N. ; Range 2 W. ; Ute P.M.

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___ ¼ of ___ ¼ of ___ ¼ of ___ ¼, Sec.___.

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973 , 7.5 min.

UTM 12 ; 698100 mE; 4331000 mN

Landowner National Park Service

ACCESS: From Fruita, travel south, then east 5.3 miles on Hwy 340 to parking area on west side of road. Walk west/southwest (through CNM gate) 500m to locality.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Lower Salt Wash

Unit Sandstones and grey green silts Position within Unit Lower Salt Wash

Narrative George L. Callison (1977) found one caudal vertebra and one rib (Suborder: Sauropodomorpha, Genus/Species indeterminate).

ADDITIONAL INFORMATION:

Sections worked Lower sandstones/silts of Salt Wash.

Type specimens None.

Paleoecological information Channel stream deposits, flow to northeast.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-9

Phylum: Chordata
Class: Reptilia
Order: Saurischia
Suborder: Sauropodomorpha

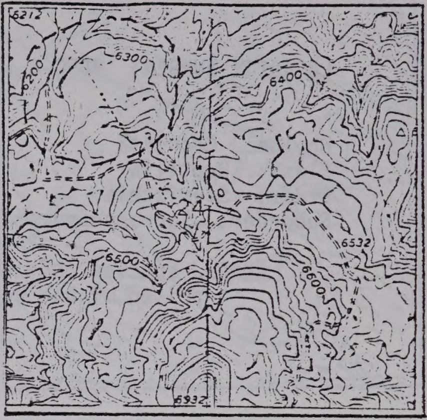
Genus, species indeterminate, portions of 1 or 2 individuals comprised of one caudal vertebra and one rib.

150

LOCALITY NUMBER: 8050-10

NAME:

Previous Number(s): Locality 4 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 102 W ; 6th P.M.

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____¼ of ____¼ of ____¼ of ____¼, Sec.____.

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973 , 7.5 min.

UTM 12 ; 695000 mE; 4328500 mN

Landowner Bureau of Land Management

ACCESS: From Fruita, drive south on Colorado Hwy 340 approx. 2.4 miles to Colorado National Monument road, turn south and drive approx. 8.0 miles, turn northwest on dirt road and travel 2.4 miles to locality.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Brushy Basin

Unit Upper Position within Unit Red beds, white sandy sediments

Narrative George L. Callison found scattered bone fragments, three semi-complete dinosaur bones (Callison 1977).

ADDITIONAL INFORMATION:

Sections worked Red beds and white sandy sediment.

Type specimens None.

Paleoecological information Flood plain deposits with some stream deposits.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-10

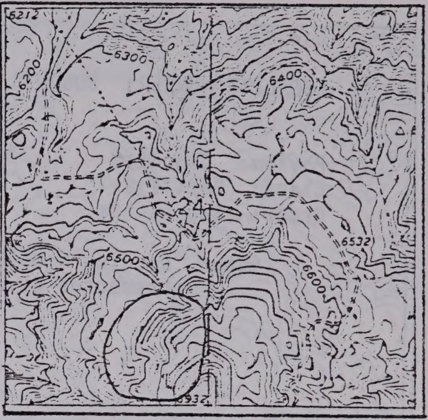
Phylum: Chordata
Class: Reptilia
Order: Saurischia

Genus, species indeterminate, portions of one or more individuals represented by 3 semi-complete bones and bone fragments.

LOCALITY NUMBER: 8050-11

NAME:

Previous Number(s): Locality 5 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 102 W. ; 6th P.M.

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___ ¼ of ___ ¼ of ___ ¼ of ___ ¼, Sec. ___.

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973 , 7.5 min.

UTM 12 ; 695500 mE; 4327700 mN

Landowner National Park Service

ACCESS: From Fruita, drive south on Colorado Hwy 340 approx. 2.4 miles to Colorado National Monument road. Turn south and drive approx. 8.0 miles, turn northwest on dirt road and travel 1.4 miles. Locality is on west side of road, on north side of large red bluff.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Middle Brushy Basin

Unit Thick red/green sandy silt Position within Unit 15m below ss capping the area.

Narrative George L. Callison (1977) found dinosaur vertebrae and skull fragments.

ADDITIONAL INFORMATION:

Sections worked Thick red and green sandy silt.

Type specimens None.

Paleoecological information Bones deposited in siltstones indicative of heavily sheet-washed floodplains.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-11

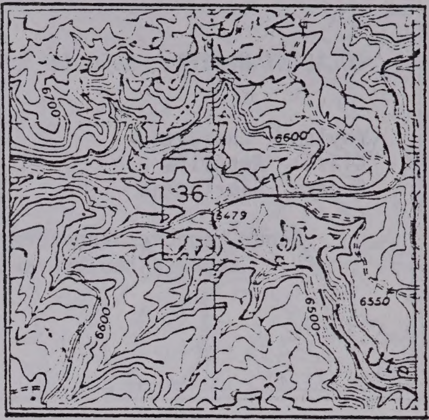
Phylum: Chordata
Class: Reptilia
Order: Saurischia

Genus, species indeterminate, portions of one or more individuals represented by vertebrae and skull fragments.

LOCALITY NUMBER: 8050-13 8050-13

NAME:

Previous Number(s): Locality 7 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 102 W. ; 6th P.M.

____ ½ of ____ ¼ of NW ¼ of NE ¼, Sec. 36 ;

____ ¼ of ____ ¼ of ____ ¼ of ____ ¼, Sec. ____.

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973 , 7.5 min.

UTM 12 ; 695500 mE; 4325800 mN

Landowner National Park Service

ACCESS: From Fruita, drive south on Colorado Hwy 340 approx. 2.4 miles to Colorado National Monument road. Turn south and drive approx. 8.0 miles, turn northwest on dirt road and travel .4 mile to locality on northeast edge of basin. Two fence posts and two downed telephone poles lie atop site.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member LowestBrushy Basin (?) or Highest Salt Wash (?)

Unit Light greenish silts Position within Unit

Narrative George L. Callison (1977) found fragments of turtle shell (well-preserved).

ADDITIONAL INFORMATION:

Sections worked Light greenish silts.

Type specimens None

Paleoecological information Bones deposited in siltstones indicative of heavily sheet-washed floodplains.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-13

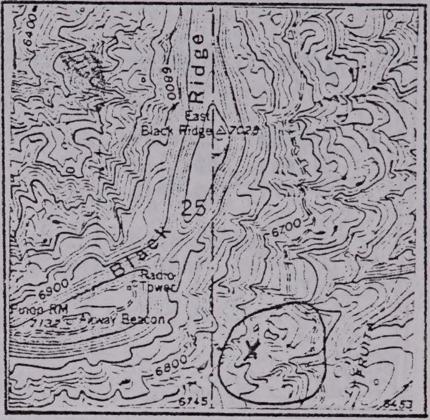
Phylum: Chordata
Class: Reptilia
Order: Chelonia

Genus, species indeterminate, skull fragments of one or more individuals.

LOCALITY NUMBER: 8050-14

NAME:

Previous Number(s): Locality 9 (Callison 1977)


6400
6800
Ridge
East
Black Ridge △7025
25
Black
Radio Tower
6900
6700
Fruita RM
7132
Airway Beacon
X
6800
6745
FRUITA
6453

LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 102 W. ; 6th P.M.

___ ¼ of ___ ¼ of SW ¼ of SE ¼, Sec. 25 ;

___ ¼ of ___ ¼ of ___ ¼ of ___ ¼, Sec. ___.

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973, 7.5 min.

UTM 12 ; 695450 mE; 4326200 mN

Landowner National Park Service

ACCESS: From Fruita, drive south on Colorado Hwy 340 approx. 2.4 miles to Colorado National Monument road. Turn south and drive approx. 8.0 miles, turn northwest on dirt road and travel .7 mile. Locality is 150m to the west (west of small knob).

DESCRIPTION:

Erathem Mesozoic

System Jurassic

Formation Morrison

Member Upper half Brushy Basin

Unit Red/grey-green silts

Position within Unit

Narrative George L. Callison (1977) found dinosaur bone (possibly proximal limb bone of Theropod).

ADDITIONAL INFORMATION:

Sections worked Red, grey-green silts below capping sandstone.

Type specimens None

Paleoecological information Bones deposited in siltstones indicative of heavily sheet-washed floodplains.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-14

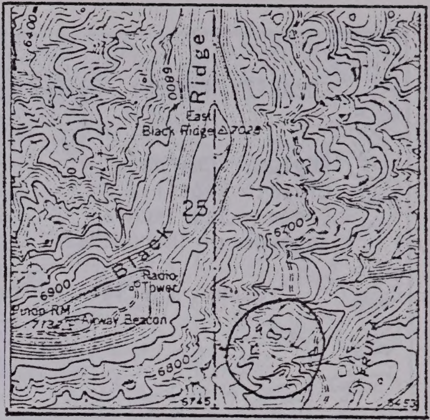
Phylum: Chordata
Class: Reptilia
Order: Saurischia
Suborder: Theropoda?

Genus, species indeterminate, possible proximal limb bone.

LOCALITY NUMBER: 8050-15

NAME:

Previous Number(s): Locality 10 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 11 S.; Range 102 W.; 6th P.M.

___¼ of ___¼ of SW ¼ of SE ¼, Sec. 25;

___¼ of ___¼ of ___¼ of ___¼, Sec.___.

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973, 7.5 min.

UTM 12; 695500 mE; 4326150 mN

Landowner National Park Service

ACCESS: From Fruita, drive south on Colorado Hwy 340 approx. 2.4 miles to Colorado National Monument road. Turn south and drive approx. 8.0 miles, turn northwest on dirt road and travel .7 mile. Locality is 100m to the west.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Upper Middle Brushy Basin

Unit Grey sandy silts Position within Unit

Narrative George L. Callison (1977) found dinosaur vertebrae and limb bone, turtle plates and limb elements with articular surfaces.

ADDITIONAL INFORMATION:

Sections worked Grey sandy silts.

Type specimens None.

Paleoecological information Bones deposited in siltstones indicative of heavily sheet-washed floodplains.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-15

Phylum: Chordata
Class: Reptilia
Order: Chelonia

Genus, species indeterminate of one or more individuals comprised of plates and limb elements with articular surfaces.

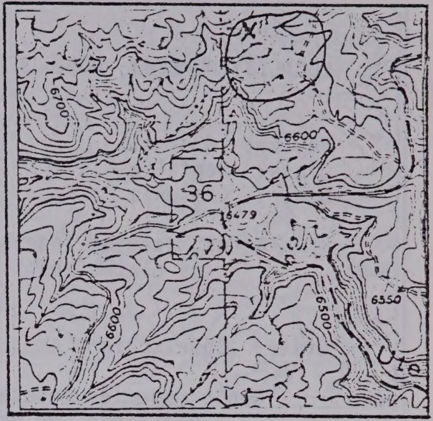
Order: Saurischia

Genus, species indeterminate of one or more individuals comprised of vertebrae and one limb bone.

LOCALITY NUMBER: 8050-16

NAME:

Previous Number(s): Locality 11 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 102 W. ; 6th P.M.

___¼ of ___¼ of NW ¼ of NE ¼, Sec. 36 ;

___¼ of ___¼ of ___¼ of ___¼, Sec.___.

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973 , 7.5 min.

UTM 12 ; 695500 mE; 4325800 mN

Landowner National Park Service

ACCESS: From Fruita, drive south on Colorado Hwy 340 approx. 2.4 miles to Colorado National Monument road. Turn south and drive approx. 8.0 miles, turn northwest on dirt road and travel .5 mile. Locality is 400m west of the road on west rim of small basin.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Lower (?) Brushy Basin

Unit Red/grey silts, some boulders from Burro Canyon Position within Unit

Narrative George L. Callison (1977) found a dinosaur bone (possibly sauropod limb) in very poor condition; large dinosaur bone fragments were present.

ADDITIONAL INFORMATION:

Sections worked Red/grey silts.

Type specimens None.

Paleoecological information Bones deposited in siltstones indicative of heavily sheet-washed floodplains.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-16

Phylum: Chordata
Class: Reptilia
Order: Saurischia

Genus, species indeterminate, bone fragments of one or more large dinosaurs.

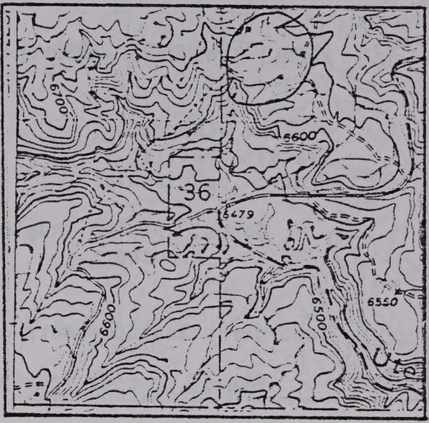
Suborder: Sauropodomorpha?

Genus, species indeterminate, one limb bone.

LOCALITY NUMBER: 8050-17

NAME:

Previous Number(s): Locality 12 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 11 S ; Range 102 W. ; 6th P.M.

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¼ of ¼ of ¼ of ¼, Sec. .

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973 , 7.5 min.

UTM 12 ; 695650 mE; 4325800 mN

Landowner National Park Service

ACCESS: From Fruita, drive south on Colorado Hwy 340 approx. 2.4 miles to Colorado National Monument road. Turn south and drive approx. 8.0 miles, turn northwest on dirt road and travel .5 mile. Locality is 200m west of the road.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Lower Brushy Basin

Unit Thick, reddish, sandy silt. Position within Unit

Narrative George L. Callison (1977) found proximal tibia (and fibula) fragments, probably crocodilian.

ADDITIONAL INFORMATION:

Sections worked Thick, reddish, sandy silt.

Type specimens None.

Paleoecological information Bones deposited in siltstones indicative of heavily sheet-washed floodplains, but with stream channel deposits.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-17

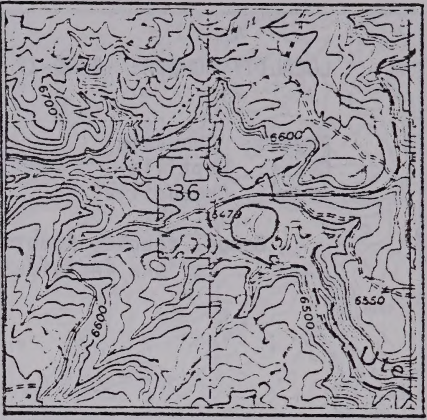
Phylum: Chordata
Class: Reptilia
Order: Crocodilia?

Genus, species indeterminate, proximal tibia and fibula fragments of one individual.

LOCALITY NUMBER: 8050-18

NAME:

Previous Number(s): Locality 13 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 102 W. ; 6th P.M.

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___¼ of ___¼ of ___¼ of ___¼, Sec.___.

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973 , 7.5 min.

UTM 12 ; 695780 mE; 4324900 mN

Landowner National Park Service

ACCESS: From Fruita, drive south on Colorado Hwy 340 approx. 2.4 miles to Colorado National Monument road. Turn south and drive approximately 9.0 miles. Locality is directly north of road across a gully, beneath a sandstone ledge.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Lower Salt Wash

Unit Sandstone ledge. Position within Unit

Narrative George L. Callison (1977) found a proximal end of dinosaur rib bone (possibly large sauropod).

ADDITIONAL INFORMATION:

Sections worked Sandstone ledge.

Type specimens None.

Paleoecological information Bones deposited in northeast-flowing stream deposits.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-18

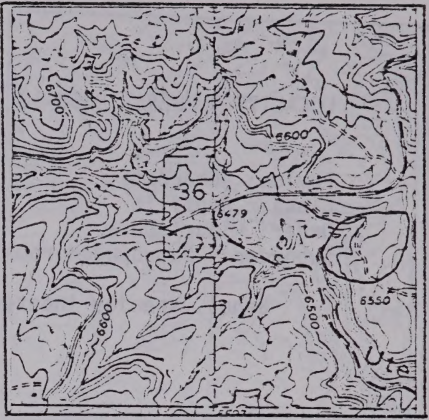
Phylum: Chordata
Class: Reptilia
Order: Saurischia
Suborder: Sauropodomorpha?

Genus, species indeterminate, proximal end of rib.

LOCALITY NUMBER: 8050-19

NAME:

Previous Number(s): Locality 14 (Callison 1977)



LOCATION:

State Colorado County Mesa

Township 11 S. ; Range 102 W. ; 6th P.M.

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__ ¼ of __ ¼ of __ ¼ of __ ¼, Sec. __.

U.S.G.S. Quad. Colorado National Monument, Colorado, 1962, rev. 1973 , 7.5 min.

UTM 12 ; 695900 mE; 4325000 mN

Landowner National Park Service

ACCESS: From Fruita, drive south on Colorado Hwy 340 approx. 2.4 miles to Colorado National Monument road. Turn south and drive approx. 9.0 miles. Locality is 150 meters northeast of road.

DESCRIPTION:

Erathem Mesozoic System Jurassic

Formation Morrison Member Salt Wash

Unit Grey flaggy limestone, .5m thick Position within Unit

Narrative George L. Callison (1977) found turtle shell fragments associated with invertebrates (molluscs).

ADDITIONAL INFORMATION:

Sections worked Grey flaggy limestone.

Type specimens None.

Paleoecological information Shallow lake bottom deposits.

Known publications Callison 1977.

LOCALITY NUMBER: 8050-19

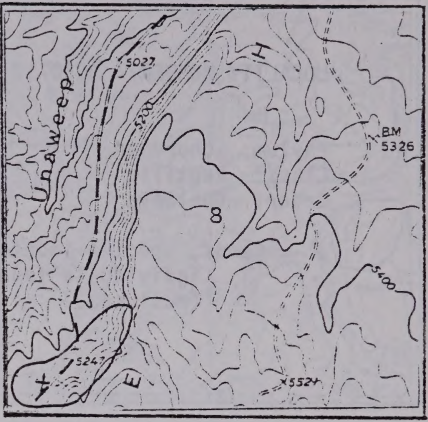
Phylum: Chordata
Class: Reptilia
Order: Chelonia

Genus, species indeterminate, shell fragments of one or more individuals found in association with invertebrates (molluscs).

LOCALITY NUMBER: 8050-20

NAME: Whitewater Femur Cast Locality

Previous Number(s): None



LOCATION:

State Colorado County Mesa

Township 13 S. ; Range 99 W. ; 6th P.M.

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___ ¼ of ___ ¼ of ___ ¼ of ___ ¼, Sec. ___.

U.S.G.S. Quad. "Whitewater, Colorado", 1969, 7.5 min.

UTM 12 ; 717700 mE; 4311950 mN

Landowner Bureau of Land Management

ACCESS: From the intersection of Colorado Hwys 50 and 141 near Whitewater, Colorado, drive southwest approx. 5.0 miles to turnoff by large boulder on the west side of road. Fossil molds are in side of this boulder, facing the road. Boulder fell from near top of hill on east side of road.

DESCRIPTION:

Erathem Mesozoic System Cretaceous

Formation Burro Canyon Member ___

Unit Sandstone layers Position within Unit basal conglomerate

Narrative In boulder, there are at least six bone molds, one good theropod femur mold, one other long bone mold, petrified wood, and three bone fragment molds. Boulder fell from cliffs across road. These cliffs were surveyed, but only fossil wood in the form of logs, pieces and stumps was found. Locality pointed out by Lance Eriksen (MWC).

ADDITIONAL INFORMATION:

Sections worked Mudball conglomerate exposures.

Type specimens None

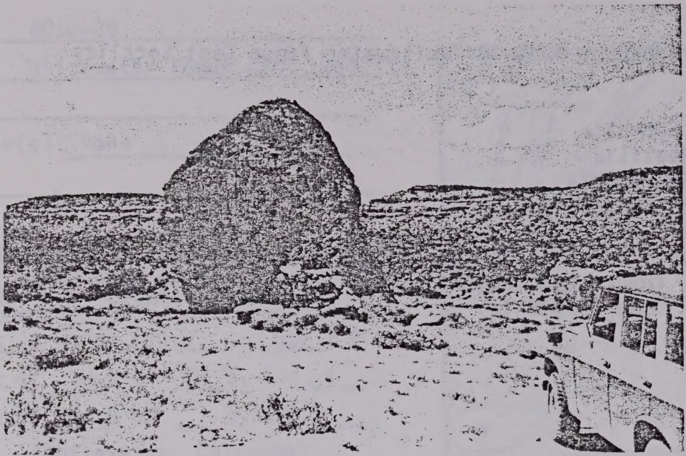
Paleoecological information Mudballs indicate floodplain (?) environment and washing of bones.

Known publications None.

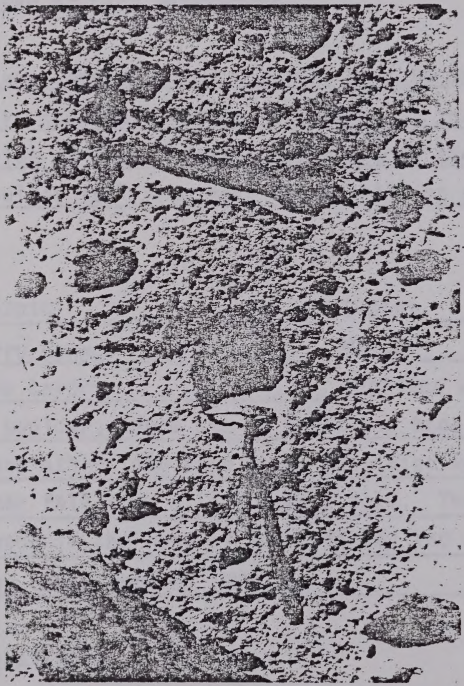
LOCALITY NUMBER: 8050-20 Whitewater Femur Cast Locality

Phylum: Chordata
Class: Reptilia
Order: Saurischia
Suborder: Theropoda

Genus indeterminate, parts of one or more individuals including femur mold, long bone mold, three smaller bone molds, three bone fragments.



Looking northwest at boulder containing fossil bone casts.



Close-up of southeast boulder face. Femur cast is above center.

LOCALITY NUMBER: 8050-21

NAME:

Previous Number(s): 13697 (U.S.G.S. Mesozoic locality).

LOCATION: Not specified; in the area of

State Colorado County Mesa

Township 1 N. ; Range 1 W. ; Ute P.M.

___ ¼ of ___ ¼ of ___ ¼ of ___ ¼, Sec. ___ ;

___ ¼ of ___ ¼ of ___ ¼ of ___ ¼, Sec. ___ .

U.S.G.S. Quad. "Corcoran Point, Colorado", 1962 , 7.5 min.

UTM ___ ; ___ mE; ___ mN

Landowner Bureau of Land Management

ACCESS: "Six miles north of Grand Junction" (Fisher et al. 1959).

DESCRIPTION:

Erathem Mesozoic System Cretaceous

Formation Mancos Shale Member

Unit "Eagle equivalent" Position within Unit 2,100 feet below top

Narrative Specimen consists of "fish remains, undetermined" collected by Fisher et al., of the U.S.G.S. (1959). Locality described as being "Eagle equivalent" and "6 miles north of Grand Junction; 2,100 feet beneath top of Mancos Shale" (Fisher et al. 1959: 31)

ADDITIONAL INFORMATION:

Sections worked (see above)

Type specimens None.

Paleoecological information Shallow Cretaceous sea.

Known publications Fisher et al. 1959.

LOCALITY NUMBER: 8050-22

NAME:

Previous Number(s): 13665 (U.S.G.S. Mesozoic locality).

LOCATION: Not specified; in the area of

State Colorado County Mesa

Township 2 S. ; Range 1 E. ; Ute P.M.

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___¼ of ___¼ of ___¼ of ___¼, Sec.___.

U.S.G.S. Quad. "Clifton, Colorado",

1962 , 7.5 min.

UTM ___; ___mE; ___mN

Landowner Private or BLM (?)

ACCESS: "Two miles north of Whitewater (Colorado)" (Fisher et al. 1959).

DESCRIPTION:

Erathem Mesozoic System Cretaceous

Formation Mancos Shale Member

Unit Middle Carlile equivalent Position within Unit 410' above Dakota(?)

Narrative Specimen consists of "Fish remains, undetermined" collected by Fisher et al. of the U.S.G.S. (1959). Locality described as "Middle Carlile equivalent, 2 miles north of Whitewater, 410 feet above Dakota (?) sandstone" (Fisher et al. 1959: 31).

ADDITIONAL INFORMATION:

Sections worked (see above)

Type specimens None.

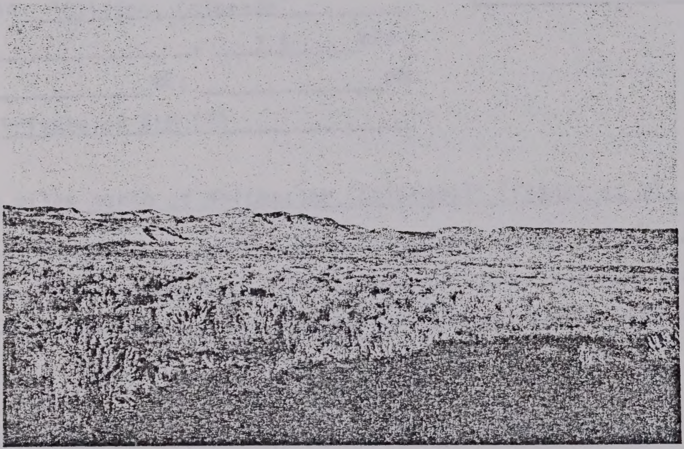
Paleoecological information Shallow Cretaceous sea.

Known publications Fisher et al. 1959.

LOCALITY NUMBER: 8050-23 Duckbill Dinosaur Footbones Locality

Phylum: Chordata
Class: Reptilia
Order: Ornithiscia
Suborder: Ornithopoda
Family: Hadrosauridae

Genus indeterminate, consisting of metatarsals and tarsals of one foot of one individual.



Looking northeast at open area with probable duckbill dinosaur locality on low hill (center).

Appendix C
Project Correspondence

FIELD MUSEUM
OF NATURAL HISTORY

July 7, 1980
Vertebrate Paleontology

Allen J. Kihm
Grand River Institute
1030 Colorado Ave.
Grand Junction, Colorado 81501

Dear Mr. Kihm:

I am sending you copies of Riggs' field notes and copies of systematic cards made for dinosaurs from Colorado. We have other specimens of dinosaurs taken from the Morrison Fm. but not from the state of Colorado. I frankly found your letter vague as to whether or not you wanted information only on Colorado specimens and especially from Riggs and Dinosaur Hills. I hope the information I am sending you answers all your questions.

Sincerely,

J. Clay Bruner

Mr. J. Clay Bruner
Collection Manager, Vertebrate
Paleontology

ROOSEVELT ROAD AT LAKE SHORE DRIVE · CHICAGO, ILLINOIS 60605 · TELEPHONE 922-9410, AREA CODE 312

CALIFORNIA STATE UNIVERSITY
LONG BEACH

21 July 1980

Dr. Allen J. Kihm
Grand River Institute
1030 Colorado Avenue
Grand Junction, CO 81501

Dear Allen:

Glad to know that you are doing the BLM project on Glade Park and Mt. Garfield. It is a most interesting area to work up.

We have not spent much time surface surveying the Riggs sites, but we did check them with preliminary walks and crawls with no avail (or fossils either!). Three years ago we provided the Colorado Natural History Association (of Colorado National Monument) with a paleontological resource survey of the Morrison Formation; it is on file in the Visitor's Center at the Monument. You might find it helpful to look at--3 persons were in the field for 2 weeks walking, crawling, and sweating over a LOT of outcrop on the Monument.

The list of specimens you requested is in the making and should be along in a few days.

The site we have been working most intensively is at the Fruita Paleontological Area located in the S½ of Sec. 13 and N½ of Sec. 24 of T1N, R3W (Ute P.M.) about 3 miles SW of Fruita, Mesa County, CO. The main fossil bearing horizon is at or near the top of the Salt Wash Member of the Morrison Formation.

Will you be in the Grand Junction area next summer? We plan to return then and perhaps we can finally get together.

Give my regards to John Crouch.

Sincerely,

George Callison

P.S. with regard to Riggs Hill and the water pipeline I would hope that the site could be avoided, particularly for scenic (esthetic) reasons but also for scientific reasons too. The scientific reasons are: 1) a significant dinosaur specimen was found there and 2) there is considerable potential for finding other specimens of large and small fossil vertebrates, invertebrates, and plants (we have at least 3 kinds of fossil wood from the Fruita site).

LONG BEACH CALIFORNIA 90840
THE CALIFORNIA STATE UNIVERSITY AND COLLEGES

Earth Sciences Museum

THE GLORY OF GOD IS INTELLIGENCE
Brigham Young University

July 28, 1980

Mr. Allen J. Kihm
Grand River Institute
1030 Colorado Ave.
Grand Junction, Colorado, 81501

Dear Mr. Kihm,

I dont believe I have collected any fossil vertebrates from within the area you describe.

No faunal list has been compiled for the Dry Mesa quarry simply because it is an unknown fauna. Galton & Jensen described a new carnivorous dinosaur Torvosaurus tanneri, new genus & species* Nothing else has yet been published.

I havent had the pleasure of meeting you but I hope you are a vertebrate paleontologist. Many v.p. surveys these days are being conducted by archaeologists..

Yours truly,

James A. Jensen

*A New Large Theropod Dinosaur from the Upper Jurassic of Colorado, BYU Geology Studies, Vol. 26, Part II, July, 1979.

Earth Sciences Preparation Laboratory, Brigham Young University, Provo, Utah 84602
(801) 374-1211, Extension 2232

1896

SCOTT M. MATHESON
GOVERNOR

STATE OF UTAH
DEPARTMENT OF COMMUNITY AND
ECONOMIC DEVELOPMENT

Division of
State History
(UTAH STATE HISTORICAL SOCIETY)

MELVIN T. SMITH, DIRECTOR
307 WEST 2ND SOUTH
SALT LAKE CITY, UTAH 84101
TELEPHONE 801 / 533-5755

July 29, 1980

Mr. Allen J. Kihm
Grand River Institute
1030 Colorado Ave.
Grand Junction, CO 81501

Dear Allen:

I can't help you with your fossil evaluation for B.L.M. Although we do have some plants and insects from the Green River Formation in the Douglas Pass area, no vertebrate material is recognizable.

The depth of the Robertson Research report on the Red Fleet Reservoir sounds on a par with your description of the West Divide exercise. Too bad!

I can empathize with your interest in overhauling the award process for Federal Paleontological Contracts, but I would have to bet against your chances for success.

Stay in touch.

Sincerely,

James H. Madsen Jr.
State Paleontologist

JHM:ro

Enclosure

State History Board: Milton C. Abrams, Chairman • Theron H. Luke • Ted J. Warner • Elizabeth Montague • Thomas G. Alexander
Dello G. Dayton • Wayne K. Hinton • Helen Z. Papanikolas • David S. Monson • Elizabeth Griffith • William D. Owens

Grand River Institute

Jason A. Lillegraven
Department of Geology
University of Wyoming
Laramie, Wyoming 82071

VII-27-1980

Dear Jay,

I ran across a reference to some UW work that I would like your help with. I'm working on a literature and collections search for the BLM concerning fossil vertebrates of the Grand Junction area. One of the BLM reports states that the University of Wyoming has shown interest in the Fruita Quarry (George Callison's site) within the last ten years.

Have you or Paul McGrew ever visited the site or its vicinity looking for fossils, or was the interest more academic?

If UW has collected at Fruita or associated sites (ie. Riggs Hill or Dinosaur Hill) I would like to know the legals on the site and have a specimen list.

I'm working on a deadline for the report of October so a timely reply would be appreciated. Thanks for your help.

Sincerely,

Allen

Allen J. Kihm

Allen,

I'm not sure what was said in the BLM report (and I'd love to know), but neither Paul nor myself have visited George's sites. I have seen some of the material in Long Beach (and would love to bludgeon Dr. Callison and run off with the fossils), but have only viewed the field area from the Interstate near Fruita. I am not a collaborator in George's research. Purely an academic and personal association.

Hope this clears things up.

Are you a "doctor" yet?

Jay

research and education in the natural and cultural sciences

1030 colorado ave. • grand junction, co. 81501 • 303/245-7868

MUSEUM OF COMPARATIVE ZOOLOGY
The Agassiz Museum

HARVARD UNIVERSITY · CAMBRIDGE, MASSACHUSETTS 02138 · TEL. 617 495-2466

September 4, 1980

Mr. Allen J. Kihm
Grand River Institute
1030 Colorado Avenue
Grand Junction, Colorado 81501

Dear Mr. Kihm:

Thank you for your letter of July 27th, 1980, requesting information on what, if any specimens were collected by the MCZ field party during our very brief paleontological reconnaissance of the Morrison exposed near Fruita and at Rabbit Valley and Ruby Canyon in 1976.

Please be advised that we located no significant specimens, although bone "scrap" was locally abundant. You are probably aware that Dr. George Callison, California State University, Long Beach, California, subsequently made a more successful search.

Yours sincerely,

Farish A. Jenkins, Jr.
Professor of Biology
Curator of Vertebrate Paleontology

FAJJr:lwm

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September 18, 1980

Dr. Allen J. Kim
Grand River Institute
1030 Colorado Ave.
Grand Junction, Colorado 81501

Dear Dr. Kim:

A number of us at Berkeley who share an interest in Mesozoic vertebrates have been delighted to see the material that George Callison has collected from the Fruita area. Jim Clark, one of our graduate students, has based his master's research on fossils collected as part of George's project. Last December I had an opportunity to see the mamalian material they had uncovered. George is doing an excellent job in developing the paleontologicial resource of the Fruita area. Other than supporting his research, ~~A~~s far as I know none of us at Berkeley has plans to carry on field work in that part of Colorado.

Cordially,

WAClemens

William A. Clemens

WAC:pw

CALIFORNIA STATE UNIVERSITY
LONG BEACH

23 October 1980

Mr. Allen J. Kihm
Department ofGeological Science
University of Colorado
Boulder, CO. 80302

Dear Allen:

Finally! the list is temporarily complete. We were waiting for additional information from Jim Clark at Berkeley who is working on the bizarre little crocodilian and has several of the specimens for study.

I hope that this list will aid you in your project. As I have recently learned, the Washington BLM people are giving the state BLM people problems over the duration of time the Fruita Paleo Area should be removed from mineral activity. Grand Junction BLM originally asked for 100 years; Washington wants 5! I have to get them to be more reasonable.

Enclosed is a photo of one of the mammal jaws.

By way of a bill for our services I estimate that Tom Rasmussen spent about 5 hours at $5.00 per hour preparing the list of specimens. The photo is free.

See you in Gainesville? Warm regards to Peter R.

Banzai,

George Callison
Professor of Biology

Thomas E. Rasmussen
SSN 540-66-6642

LONG BEACH CALIFORNIA 90840
THE CALIFORNIA STATE UNIVERSITY AND COLLEGES

THE SIMROE FOUNDATION
5151 EAST HOLMES STREET
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5 November 1980

Mr. Allen J. Kihm
Grand River Institute
1030 Colorado Avenue
Grand Junction, Colorado 81501

Dear Mr. Kihm:

I am replying to your letter of 21 October 1980, just received.

As you know, I attended the BLM meeting about the Fruita site in 1977. I then felt that the chances of recovering important Jurassic vertebrates, including mammals and small non-dinosaurian reptiles, at that site were excellent, and I recommended that this search be continued along some rather specific lines.

I understand that this recommendation was followed, and I have heard indirectly and (once, by telephone) directly from Dr. Callison that he had indeed collected some excellent specimens of mammals. I have not myself seen any of those specimens, and I know nothing from any source about "the most recently recovered material" to which you refer in your letter. There has been no publication on any of the mammals found there except for a brief mention of the one fragment found before the 1977 meeting.

Under these circumstances I am not able to judge the present position there. If work at this locality is in fact producing good specimens and if these are being competently studied and publications on them are in progress and will soon appear, I certainly would recommend continuation of this work. I must, however, withhold any further opinion until and unless I am more explicitly informed.

Sincerely,

G. G. Simpson

George Gaylord Simpson

GGS/bf

Museum of Northern Arizona

Dr. Allen J. Kihm
Grand River Institute
1030 Colorado Avenue
Grand Junction, Colorado 81501

November 18, 1980

Dear Dr. Kihm:

Ned Colbert turned your recent letter over to me and asked that I write to you regarding our interest in Morrison vertebrates from the Grand Junction area. I have checked our locality files and can find no reference to any MNA localities in the Grand Junction area. So far as I have been able to learn, nobody currently at MNA has had any interest or active research involvement, nor does anyone have any immediate plans for work with Morrison vertebrates near Grand Junction. Perhaps if you sent me a copy of your BLM memo I might be able to determine whether someone working for us in the past was involved with the Morrison Formation in this area.

Yours sincerely,

Timothy Rowe
Senior Paleontologist

ROUTE 4 BOX 720 FLAGSTAFF, ARIZONA 86001 (602)774-5211

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